Factors influencing mathematics achievement of secondary school students in India

by

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Declaration of Originality

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Abstract

Mathematics achievement and its importance to the future learning and careers of students is a recurrent concern of academics, researchers, and media. In a developing country like India, along with the technological advancement, achievement in mathematics will be of paramount importance. This study looked at mathematics achievement of secondary school students in Kerala, India. The study investigated how mathematics anxiety, attitude towards mathematics, and parental involvement influenced the mathematics achievement of the participants in this study. The study assessed how the constructs were inter-related and how gender influenced these relationships. The participants were Year 9 and Year 11 students and their parents from a private school in Kerala.

A combination of quantitative and qualitative research methods was used to collect data for the study. A student questionnaire gathered data on students' perception of their mathematics anxiety, attitude towards mathematics, and their parents' involvement in their mathematics learning. A parent questionnaire was used to understand parents' perceptions of their mathematics anxiety, attitude towards mathematics, and their own involvement in their child's mathematics learning. A standardised achievement test in mathematics was used to measure the students' achievement. Semi-structured interviews were conducted with a representative sample of the student and parent pairs in order to gain a deeper understanding of the participants' views about the constructs, their inter-relationships and their relationship to mathematics achievement.

The study found that parental involvement was significantly and positively associated with attitude towards mathematics and but had no significant association with mathematics anxiety. Mathematics anxiety and attitude towards mathematics were

significantly and positively related. The relationship between parental involvement and mathematics achievement was non-significant. Student attitude towards mathematics, and mathematics anxiety were also not significantly related to mathematics achievement. Gender was found not to have any influence on the variables. Interview data revealed that all of the parents had high expectations for their children's mathematics achievement that they had communicated through consistent reinforcement.

The study was limited in sample size constraining the generalizability of its findings and its cross-sectional nature precludes the establishment of a casual relationship among the variables. The timing of the administration of the student questionnaire and achievement test on the same day, a week before the second term examinations may have affected the results of the study.

In spite its limitations, the study opens several avenues for further research in the field of mathematics achievement of secondary school students, particularly in India. A longitudinal study with participants from public and private schools as well as schools in urban and rural areas may help in understanding the casual relationship among the variables considered in this study and others. It would be worthwhile, for example, to consider the influence on mathematics achievement of contextual factors such as teacher-student relationship, teacher competency, peer support, socio-economic status and educational level of parents.

This dissertation is dedicated to God Almighty for the past, the present and the future

To my husband, Athanasius, and my sons, Arul and Paul

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Acronyms

CISCE	-	Council for the Indian School Certificate Examinations
CBSE	-	Central Board of Secondary Education
NIOS	-	National Institute of Open Schooling
FSMAS	-	Fennema-Sherman Attitudes Scales
PISA	-	The Programme for International Student Assessment
PAQ	-	Parental Authority Questionnaire
OCED	-	Organisation for Economic Co-operation and Development
LSAY	-	Longitudinal Study of American Youth
NAEP	-	National Assessment of Educational Progress
VCE	-	Victorian Certificate of Education
NAPLAN	-	National Program for Literacy and Numeracy
UiTM	-	University Teknologi MARA
TOSRA	-	Test of Science Related Attitudes
ALM	-	A-level medicine
MANOVA	-	Multivariate analysis of variance
ANOVA	-	Univariate analysis of variance
PCM	-	Partial Credit Model
RSM	-	Rating Scale Model
AMOS	-	Analysis of Moment Structures
SEM	-	Structural equation modeling
ML	-	Maximum Likelihood
CFI	-	Comparative fit index
GFI	-	Goodness-of-fit index
IFI	-	Incremental fit index
RMSEA	-	Root mean squared error of approximation
NFI	-	Normed fit index
MGCFA	-	Multi-group confirmatory factor analysis
CMV	-	Common method variance
MGSEM	-	Multi-group structural equation modeling
gcr	-	Roy's greatest characteristic root
df	-	degrees of freedom
NELS	-	National Educational Longitudinal Study
IEA	-	International Association for the Evaluation of Educational Achievement
SIMS	-	Second International Mathematics Study
TIMSS	-	Trends in International Mathematics and Science Study
MARS	-	Mathematics Anxiety Rating Scale
MAQ	-	Mathematics Attitudes Questionnaire

Abbreviations

sattitude	-	students' report of their general attitude towards maths and success in mathematics
susefulness	-	students' report of usefulness of mathematics
sconfidence	-	students' report of confidence in mathematics
sanxiety	-	students' report of their mathematics anxiety
smotivation	-	students' report of their motivation
sparentattitude	-	students' report of their parents' attitude towards maths and child's maths study
sparentbeh	-	students' report of their parents' behaviours in child's maths learning
sparsty	-	students' report of their parents' parenting style
pparentbeh	-	parents' report of their behaviours in child's maths learning
panxiety	-	parents' report of their mathematics anxiety
pexpectation	-	parents' report of their expectation of child's mathematics learning and future education
pattitude	-	parents' report of their own attitudes to maths and child's maths study
pparsty	-	parents' report of their own parenting style

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CHAPTER 1 INTRODUCTION

1.1 Preamble

"Mathematics is a key science for the future, through both its fundamental development and its enabling role for science, engineering and technology. This is illustrated by dramatic advances in communications, bioinformatics, the understanding of uncertainty and dealing with large data sets" (Lemaire, 2003, p. 21). The former Director of the Division of Mathematical Sciences at the USA National Science Foundation, Prof. Philippe Tondeur, has observed that the 21st century is going to witness greater opportunities for mathematical sciences. Mathematical thought and concepts will become the primary navigational tools in the data driven world (Lemaire, 2003). As a result of the technological advancement in today's societies, mathematical knowledge has become essential for the success of individuals and for the progress and security of nations.

For success in tertiary education and beyond, a strong foundation in secondary school mathematics is essential (Cappellari, Lucifora, & Pozzoli, 2008; Steinberg, Varua, & Yong, 2010). Despite the importance of mathematics in life and in the study of other science subjects, there has been a decline in the number of students enrolled in the tertiary mathematics courses in India as well as in western countries (Mishra, 2011; Smith, 2011). When capable students avoid the study of mathematics, it reduces their career options and thereby limits the nation's resource base in science and technology (Hembree, 1990).

The researcher's experience as a mathematics teacher brought her to this study. She has first-hand experience of students who described mathematics as a difficult, boring, abstract or uninteresting subject. Whether this view of mathematics was due to perceived difficulty of mathematics or students' inability to do mathematics, hard work and effort brought about better achievement for many of them. This experience has led the researcher to consider why students perceive mathematics as a difficult subject. Why are they not confident in their ability to do mathematics? What are the factors affecting their mathematic achievement? These experiences resulted in the present study that aimed to examine the influence of selected factors on mathematics achievement of secondary school students.

1.2 Conceptual framework of the study

Many researchers have studied factors affecting mathematics learning and performance of students (Beaton & O'Dwyer, 2002; Kifer, 2002; Ma & Klinger, 2000; Papanastasiou, 2002; Reynolds & Walberg, 1991). Among factors that have been studied extensively in relation to mathematics learning and achievement are mathematics anxiety (Cates & Rhymer, 2003; Ma & Xu, 2004b; Zakaria & Nordin, 2008); attitude towards mathematics (K. C. Cheung, 1988; Hannula, 2002); mathematics self-efficacy (Pietsch, Walker, & Chapman, 2003; Williams & Williams, 2010); teachers (Beverley, 2002; Hill & Rowe, 1998); peers (Berndt & Keefe, 1995; Wentzel, 1999); gender (Gray, 1996; Kenney-Benson, Pomerantz, Ryan, & Patrick, 2006); and parental involvement (Levpuscek & Zupancic, 2009; Vukovic, Roberts, & Wright, 2013; Yan & Lin, 2005). The personal experiences of the researcher as a student, mother and a mathematics teacher have influenced her in the selection of the three variables, mathematics anxiety, attitude towards mathematics, and parental involvement, for the study. The variables of interest were selected after reviewing the literature on mathematics achievement of students, in particular secondary school students. Mathematics achievement was, for this study, defined as the level of attainment in any or all mathematical skills operationalised by performance on a test.

1.2.1 Mathematics anxiety

Mathematics anxiety has been regarded as the feelings of fear or tension in situations involving mathematics problem solving or any mathematics-related activities (Ashcraft, 2002; Ma & Xu, 2004b). Dreger and Aiken (1957, p. 344) defined mathematics anxiety as the "the presence of a syndrome of emotional reactions to arithmetic and mathematics". Mathematics anxiety was defined by Bandalos, Yates, and Thorndike-Christ (1995) as a combination of test anxiety, thoughts of failure, low self-confidence, and a negative outlook on the learning of mathematics. For the purpose of this study, mathematics anxiety was defined as students' negative emotional reactions to mathematical concepts and testing situations (F. C. Richardson & Woolfolk, 1980).

Mathematics anxiety has been identified at all levels of schooling from lower primary to tertiary years (Ma & Kishor, 1997) and has been found to influence the mathematics achievement of students. A small negative association has been observed between mathematics anxiety and achievement consistently over several decades (Eccles & Jacobs, 1986; Hembree, 1990; Ma, 1999; Woodard, 2004). Zakaria and Nordin (2008) also found that pre-tertiary students with high mathematics anxiety scored significantly lower in achievement than less anxious students. In a similar vein, Quilter and Harper (1988) found that highly mathematically anxious adults scored lower in mathematics than those with low mathematics anxiety.

Mathematics anxiety also affects the career options of individuals both by negatively influencing their mathematical attainment and their inclination to pursue mathematically dependent options. An individual's level of attainment in mathematics at the secondary and university levels affects a student's range of career options (Lent, Lopez, & Bieschke, 1993). Students with high mathematics anxiety are more likely to avoid mathematics-related activities, courses or majors, (Ashcraft, 2002; Ashcraft & Kirk, 2001; Betz, 1978; Hackett, 1985; Zettle & Houghton, 1998), thereby limiting their career options.

1.2.2 Attitude towards mathematics

According to Aiken (1970), an attitude is an individual's learned predisposition to respond in a positive or negative way to an object, concept, situation, or another individual. Somewhat similarly, McLeod (1992) defined the term attitude as the "affective responses that involve positive or negative feelings of moderate intensity and reasonable stability" (p. 581). Generally, attitude towards mathematics refers to individuals' beliefs and feelings about mathematics (Kulum, 1980; Leder, 1987). Attitude towards mathematics has been defined as a negative or positive emotional disposition towards mathematics (McLeod, 1992; Zan & Martino, 2007). The above definitions of the construct encompass the emotional side of an individual's reaction to a situation, object or a subject of study. Accordingly, for the purpose of this study, attitude towards mathematics was defined as a combined measure of like or dislike towards mathematics, an inclination to engage in or avoid activities in mathematics, a belief that one is good or bad at mathematics, and a belief about the usefulness of mathematics as described by Ashcraft (2002) and Ma and Kishor (1997).

Generally a strong relationship has been assumed between students' positive attitude towards mathematics and achievement in the subject (Ma & Kishor, 1997; Nicolaidou & Philippou, 2003). Teachers and educators believe that students learn and achieve better if they have interest in mathematics and a liking for the subject (Suydam & Weaver, 1975). Nevertheless, researchers have reported varying findings about the relationship. For example, some researchers have found weak relationships (Deighan, 1970; Wolf & Blixt, 1981), others have found relationships that are statistically significant, but not strong (Hammouri, 2004; Ma & Kishor, 1997), yet others have found no significant relationship between attitude towards mathematics and mathematics achievement (Cain-Caston, 1993).

1.2.3 Parental involvement

In general, parental involvement is referred to as the participation of parents in the education of children to enhance their social and academic achievement (Fishel & Raimirez, 2005). Because parental involvement encompasses various parental practices and behaviours, most researchers regard the construct as multi-dimensional (Brown, 1994; Epstein, 1995). Multi-dimensional definitions of parental involvement include helping with homework or supervising home work, volunteering or attending school events (Epstein, 1987, 1991), encouragement of academic success, having high expectations for achievement (Hoover-Dempsey & Sandler, 1995, 1997), and parent-child communication (McNeal Jr, 1999). In keeping with these definitions, for the purpose of the study, parental involvement has been defined as parental participation in school-related activities (such as monitoring of home study and attending parent-teacher interviews), parental encouragement of academic success, and parental expectations of educational attainment (Chen & Gregory, 2010) and parenting style.

Depending on the way the construct parental involvement has been operationalised and the outcomes measured, the findings about the influence of parental involvement on students' academic achievement have been varied (Catsambis, 2001; W. Fan & William, 2010). The support of knowledgeable, involving, and supportive parents has been found to improve the academic performance and behaviours of their children(Epstein, 1992). Researchers have found a positive association between parental expectation and students' academic achievement in general (X. Fan, 2001; Griffith, 1998; Hubbard, 1999). McNeal Jr (1999) found that communication between parent and child was associated with higher achievement in science. On the other hand, parent participation in parent-teacher association meetings was found to be negatively related to science achievement (McNeal Jr, 1999). When considering achievement in mathematics the findings regarding parent-child communication, or parental expectation seem also to apply. For example, researchers have found that home-based parental involvement (e.g., communication between parent-child, parental expectation of success, encouragement of mathematics learning) facilitates mathematics achievement of elementary school students (Fantuzzo, King, & Heller, 1992; Jeynes, 2007; C. Nye, Turner, & Schwartz, 2007).

Parenting style covers the totality of the emotional feeling in a parent-child relationship and is considered as a global construct (Darling & Steinberg, 1993). Baumrind (1971, 1978, 1991) suggested three main parental classifications: permissive, authoritative, and authoritarian. According to Baumrind (1978), permissive parents are non-controlling, moderately responsive to child's needs, and use minimum punishment. Authoritative parents, are reasonably controlling, affectionate, responsive, and they encourage autonomy (Baumrind, 1978). On the other hand, authoritarian parents are demanding, non-responsive, and exhibit high levels of control (Baumrind, 1978). A number of studies have found a positive relationship between authoritative parenting and academic performance of students (Baumrind, 1978; Reitman, Rhode, Hupp, & Altobello, 2002; Steinberg, Elmen, & Mounts, 1989).

The studies reviewed above have shown that mathematics anxiety, attitude towards mathematics and parental involvement influence mathematics achievement of students in all levels of schooling. Gender was also found to influence the above mentioned factors and the inter-relationship among them. The influence of gender on the selected factors and their relationships is discussed in detail in Chapter 2. In previous research studies, these factors have been studied in pairs to understand their interaction with each other, and they have each been studied individually to understand their influence on mathematics achievement. Very few studies have been found to investigate the influence of mathematics anxiety, attitude towards mathematics and parental involvement on mathematics achievement together in a single research study. Also not much has been done to study the effect of these factors on achievement in mathematics, particularly among secondary school students in India. This study investigated the influence of mathematics anxiety, attitude towards mathematics and parental involvement on mathematics achievement of secondary school students in India. Further, the researcher's experience as a secondary school teacher in India impacted her in choosing these variables in the present study.

1.2.4 Conceptual model

A conceptual model was built based on research findings discussed in the earlier sections. The model included the variables; mathematics anxiety, attitude towards mathematics, and parental involvement. These variables were hypothesised to influence mathematics achievement among secondary school students as shown in Figure 1.1. The study also investigated the inter-relationships among the variables and the influence of gender on these variables.

The model shown in Figure 1.1 shows the ways in which the variables under the study interact based on the literature. Mathematics achievement appears to be influenced by mathematics anxiety, attitude towards mathematics, parental involvement and gender. Attitude towards mathematics and mathematics anxiety appear to be closely related and are influenced by parental involvement, and gender. In addition, parental involvement appears to be influenced by gender.

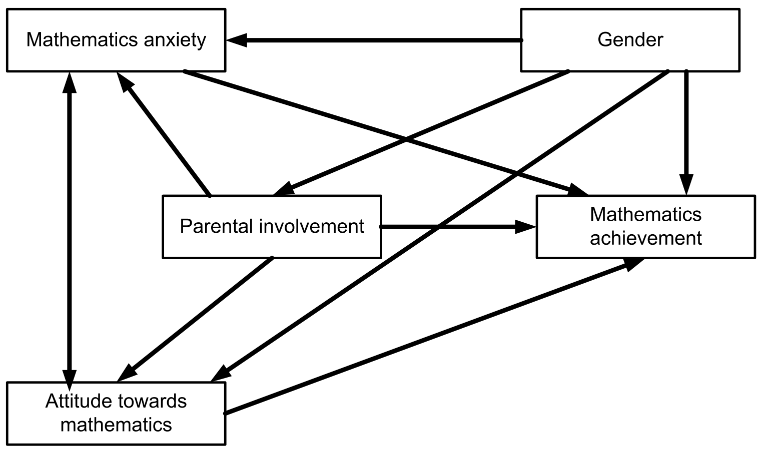


Figure 1.1. Conceptual model for the study showing the hypothesised relationship between the variables

The major research questions that framed the study were based on the conceptual model. They were:

1. How does parental involvement in learning influence mathematics achievement of secondary school students in India?
2. How does attitude towards mathematics influence mathematics achievement of secondary school students in India?
3. How does mathematics anxiety influence mathematics achievement of secondary school students in India?
4. How do parental involvement, attitude towards mathematics and mathematics anxiety interact to influence the mathematics achievement of secondary school students in India?
5. Are there gender differences in relation to any of these variables and/or their relationships?

1.3 Research site

As a consequence of industrialisation, more skilled workers are required in industries and organisations to replace manual labourers in India. The technological growth happening in India also requires a highly skilled population (Levy & Murnane, 2004). Higher levels of education are, therefore, required from its citizens, and students' educational achievement has become an important factor in deciding one's future and self-worth in Indian society. Consequently Indian parents and students attach more importance to academic work than to extra-curricular activities (Verma, 1998). Indian parents, as in many other Asian cultures, pressure their children to excel in their academic studies (Nisbitt, 2003). The researcher selected this site for the project to understand how the selected variables impact the mathematics achievement of secondary school students in the present Indian context. The education system prevalent in the particular Indian state in which the school that was the site of the study is located is outlined in the next section.

1.3.1 Education System in Kerala, India

Keralam (Kerala), the land of kera or coconut, is a small state lying along the coastline to the extreme south west of India. The official language of Kerala is Malayalam. Other languages such as Konkani, Tulu, Kannada, Hindi, Mahl and various tribal languages are also spoken by ethnic minorities.

The school education system in Kerala is divided into three stages; Primary or Elementary Education, Secondary Education, and Higher Secondary Education. The primary stage is further divided into Lower primary (ages 6-10) and Upper primary (ages 11 and 12). Secondary education includes schooling for students aged 13 to 15 years. Higher secondary stage comprises Classes 11 and 12 for students aged 16 and 17 years who can choose one of the discipline areas; humanities, commerce, or sciences (Indian Government, 2005). Upon completing the required coursework in Classes 11 and 12, students can enrol in general or professional undergraduate programmes. Vocational schools train students who do not want to enrol in any undergraduate degree, for a business, or trade or other occupation that does not require a degree qualification.

Schools in Kerala are run by the government, individuals, private trusts, or churches. Each school is affiliated with the Kerala State Educational Board, Council for the Indian

School Certificate Examinations (CISCE), Central Board of Secondary Education (CBSE), or the National Institute of Open Schooling (NIOS). The medium of instruction in most of the self-financing institutions (i.e., schools run by individuals, private trusts, or churches) is English, while government and government aided schools offer classes in English and Malayalam (Indian Government, 2005). The particular school that was the site of this study was run by the Catholic management (fee paid by parents) and offered secondary education for boys and girls in English.

1.4 Method

The study employed a mixed method research design involving both quantitative and qualitative approaches as described by Creswell and Clark (2007). The mixed method approach was chosen for the study because that design lends itself to the investigation of a complex phenomenon such as considered in this study involving factors relating to school and home. Mixed methods studies can maximise understanding and facilitate interpretation of results. In this approach, the researcher collects information both in numeric forms using, for example, questionnaires requiring responses on Likert scales, and text forms (e.g., using interviews) so that in the final form, the data comprise both qualitative and quantitative information (Creswell & Clark, 2007). The mixed methods approach enables the researcher to study the research problem from different perspectives to get a better understanding of the phenomenon under study (Thurmond, 2001). Since the researcher uses more than one approach, it provides a stronger platform than other designs for conclusions (Yin, 2006). Though the study employed a mixed method approach, qualitative data was used to complement the quantitative data. In this study more emphasis was given to quantitative data. The results of the qualitative data were used to complement the quantitative findings of the study wherever possible.

The instruments used for collecting quantitative data included a student questionnaire, an achievement test in mathematics, and a parent questionnaire adapted from the Shortened Form of Fennema-Sherman Attitudes Scales (Mulhern & Rae, 1998), the Programme for International Student Assessment (PISA) (PISA, 2009), and the Parental Authority Questionnaire (PAQ) (Buri, 1991). Interviews were used to collect qualitative data from students and parents.

1.5 Significance of the study

The study has both theoretical and practical implications for the field of mathematics education for secondary school students. The theoretical contribution is in bringing together the three distinct research areas of parental involvement, mathematics anxiety, and attitude towards mathematics, providing new insights and suggesting an agenda for further research in the field.

Practically, the relationships found from the study have potential to improve secondary school mathematics teaching and learning. The findings may add to the understanding of the effect of parental involvement, students' mathematics anxiety, and attitude towards mathematics on mathematics achievement, and reinforce the importance of parental involvement in mathematics achievement of secondary school students while providing insights into aspects of this involvement that are helpful. The findings may assist parents to help their children to become more confident and optimistic in their mathematics learning and help them to have a positive sense of their ability in mathematics. Teachers may use the results of the study to change their teaching methods and strategies for the benefit of students. Education policy makers can formulate new policies in the secondary school sector based on the findings of this study. Ultimately, the study can help secondary school students to improve their mathematical skills to achieve their academic potential.

Importantly, little research has been done in India on these variables and the findings from the research studies conducted mainly in the western countries may not apply in the Indian context. Thus this study adds to the knowledge of these variables in Indian context.

1.6 Limitations of the study

The study was limited by a relatively small sample size of 135 students and 118 parents. It was conducted among students and parents from only one urban private school in South India. The interpretation of the results beyond the context should, therefore, be made with caution. The study was also limited in its capacity to explain causal relationship between the variables because of its cross-sectional nature.

1.7 Chapter Summary

This chapter has provided information on the background of the research study and its conceptual framework. The introduction chapter was presented as to give a comprehensive overview of the thesis. The context of the study was briefly described and the significance of the study explained. Chapter 2 presents the review of the literature that provided the foundation for the study relevant to the variables considered, and how they influence mathematics achievement of students, particularly secondary school students. Chapter 3 describes the sample, the instruments, and the data collection procedures used in the study. Chapter 4 outlines the details of data analysis approaches employed. In Chapter 5, the findings from the quantitative and qualitative data analysis are presented. The last chapter, Chapter 6, presents a discussion of the results, limitations of the study as well as suggestions for future research.

CHAPTER 2 LITERATURE REVIEW

2.1 Introduction

Achievement in mathematics has been for the past several decades a topic of investigation for researchers around the world concerned with improving the quality of mathematics education. Mathematics achievement of students in the high school years has been found to be significant to success in tertiary mathematics and performance in other science subjects, as well as contributing to better career options and quality of life (Barry & Chapman, 2007; Halpern et al., 2007; Murrane, Willett, & Levy, 1995; Wilson & MacGillivray, 2007). There is, however, increasing concern about levels of student mathematics achievement and quality of mathematics education globally (Martin, Mullis, Gregory, Hoyle, & Shen, 2000). Substantial evidence shows that there is a decline in the number of students selecting sciences and mathematics in Years 11 and 12, in Australia as well as in many OECD (Organisation for Economic Co-operation and Development) countries (Department of Education, Science and Training, 2006; Fullarton, Walker, Ainley, & Hillman, 2003; OECD Global Science Forum, 2006; Osborne & Collins, 2001). India is not an exception. In particular, a large number of students in India drop out of school even before they reach secondary level (Ramanujam, 2012). It has been reported that in India, the number of graduates selecting mathematics-related careers has been declining, in spite of the importance of mathematics in today's scientific world (Mishra, 2011).

Studies have identified several factors influencing mathematics achievement during the school years. These include mathematics self-concept (Abu-Hilal, 2000; Wang, 2007); mathematics anxiety (Ashcraft, 2002; Hembree, 1990; Ma & Xu, 2004a); attitudes towards mathematics (Hannula, 2002; Hart, 1989; Lamb & Fullarton, 2002); mathematics self-efficacy (Hackett & Betz, 1989; Pietsch et al., 2003; Williams & Williams, 2010); parental involvement in academic learning (Coleman, 1988; Epstein, 1991; Jeynes, 2005); teachers (Beverley, 2002; Hill, 1994; Hill & Rowe, 1998); peers (Berndt & Keefe, 1995; Wentzel, 1999); and gender (Gray, 1996; Kenney-Benson, Pomerantz, Ryan, & Patrick, 2006). The researcher's personal experiences as a student, mother and a mathematics teacher influenced her in selecting the variables (i.e., mathematics anxiety, attitudes towards mathematics, and parental involvement) for the study. In addition, not many studies have been done among secondary school students in India to study the influence of the above mentioned factors on mathematics achievement. Thus the study investigated the influence of students' mathematics anxiety, attitudes towards mathematics, and parental involvement on mathematics achievement of secondary school students in India.

There is a plethora of research studies on mathematics anxiety, attitude towards mathematics, parental involvement, and mathematics achievement among school students as well as tertiary students. The majority of the research studies on the selected variables were conducted in the western context. There is a paucity of research studies in India investigating these variables and their influence on mathematics achievement. Attention has been given to include studies investigating the variables of interest among secondary school students in the Indian context wherever possible. Effort was made to look into as many studies as possible to understand the relationship among the variables considered from non-western context. The contexts of the studies reviewed including, the age of participants, the school subjects under consideration, the country in which the study took place, the size of the sample, the data collection tools were mentioned wherever available. Effort was also made to critique the studies and to highlight similarities and differences between them and the current study especially when these might explain differing findings.

2.2 Mathematics anxiety

Mathematics anxiety has been found to influence the mathematics performance of students at all levels of schooling (Ashcraft, 2002; Hembree, 1990). F. C. Richardson and Woolfolk (1980) defined mathematics anxiety as a condition in which students experience negative responses to mathematical concepts and testing processes. Speilberger (1972, p. 38) stated that anxiety is a “condition characterized by feelings of tension and apprehension”. According to Spielberger, there are two components for this condition: trait anxiety and state anxiety. State anxiety is an emotional condition which varies in intensity and changes with time. On the other hand, trait anxiety is a feeling at the core of an individual who considers certain situations to be dangerous or threatening. Mathematics trait anxiety is specific to mathematics education contexts and related activities, and can interfere with achievement in mathematics and further learning in mathematics. It is also relatively constant and difficult to change. Mathematics anxiety has been found to be influenced by various factors including parents, teachers (Goldstein, 1999; Jennison & Beswick, 2009), peers and teaching methods (Ma, 1999; J. Turner et al., 2002).

Researchers over the years have agreed that mathematics anxiety takes root in the elementary years, peaks during the secondary education, and continues to a lesser degree through university years (Jackson & Leiffingwell, 1999; Lazarus, 1974; Uusimaki, 2004). The early stages of secondary schooling have been identified as crucial in the development of mathematics anxiety (Hembree, 1990), but more recently Bekdemir (2010) found that mathematics anxiety among his participants (senior elementary pre-service teachers) appeared to have formed during senior secondary school years, mainly in Years 9 to 11.

It has been found that mathematics anxiety interferes with achievement in mathematics. For example, researchers found a negative relationship between mathematics anxiety and mathematics achievement among students in Year 6 through to tertiary level (H. Z. Ho et al., 2000; Ng, 2012; Woodard, 2004). When studying how mathematics anxiety affected the mathematics learning of pre-tertiary students in terms of achievement and motivation, Zakaria and Nordin (2008) found that students with low mathematics anxiety achieved significantly higher than those with high or moderate anxiety in relation to mathematics. Similarly Wither (1998) observed a negative relationship between mathematics anxiety and mathematics achievement among Year 6 to Year 10 students. These findings are consistent with those of other researchers who have found that students with higher mathematics anxiety perform less well in mathematics (e.g., H. Z. Ho et al., 2000; B. Y. Lee, 1992; Tocci & Engelhard Jr., 1991). Consistent with these findings McCarty (2007) and Luigi et al. (2007) also found that generally, a high level of general anxiety was related with low academic performance.

Hembree's (1990) meta-analysis of studies of mathematics anxiety found a negative correlation between mathematics anxiety and performance in mathematics. Newstead (1998), however, argued that the direction of causality in the relationship between mathematics anxiety and mathematics achievement is ambiguous. One of the reasons for this may be the dependence of studies on cross-sectional data. Using the Longitudinal Study of American Youth (LSAY) data, Ma and Xu (2004a) observed that prior low mathematics achievement was found to cause higher mathematics anxiety in succeeding years through the entire junior grades (Year 7-Year 9) as well as in senior school grades (Year 10-Year 12), especially for boys. In contrast, there was very little evidence of causation in the opposite direction at any grade level.

In India, Karimi and Venkatesan (2009) studied the relationship between mathematics anxiety, in mathematics performance, and academic hardiness (attitude to academic success) among 10^{th} grade students in nine different secondary schools in Karnataka, India. They found a significant negative correlation between mathematics anxiety and performance in mathematics among the students.

One of the main features of mathematics anxiety has been its connection with avoidance of mathematics (Friman, Hayes, & Wilson, 1998; Ma & Xu, 2004a). Students with high mathematics anxiety tend to avoid mathematics-related activities, courses or majors (Ashcraft & Kirk, 2001; Chinn, 2009; Zettle & Houghton, 1998), drop out of mathematics, especially advanced courses, prematurely, and avoid mathematics-related careers (see Hembree, 1990; H. Z. Ho et al., 2000). According to Preis and Biggs (2001), there is a cycle of mathematics avoidance, involving four phases, namely, (a) negative reactions to mathematical situations as a consequence of negative past experiences in mathematics; (b) avoidance of mathematical situations; (c) poor preparation for assessments in mathematics; and (d) poor performance in mathematics. They suggested that an individual's poor performance in mathematics may take him/her back to the beginning of the cycle, which, if repeated, may result in the individual coming to the conclusion that he/she cannot perform well in mathematics.

Review of the mathematics anxiety literature indicated that only a few studies have been reported on the topic in India. Not much is known about mathematics anxiety among Indian high school students and its influence on mathematics achievement. With this in mind, the present study attempted to address the gap in the literature by looking at the relationship of mathematics anxiety and achievement in mathematics for Indian students.

2.3 Attitude towards mathematics

Students' attitude towards mathematics has been considered as important in their learning, participation, and achievement in mathematics (Papanastasiou, 2002; Shashanni, 1995). In general, it is believed that a positive attitude towards a subject influences a student's success in that subject. Attitude towards mathematics has been defined as a positive or negative evaluation of a psychological object (Ajzen & Fishbein, 1980). According to Hannula (2002), four different evaluative processes were associated with attitude towards mathematics, namely, (a) emotions experienced while engaging in mathematical activities; (b) emotions evoked by the concept of mathematics; (c) evaluations of the results of doing mathematics; and (d) evaluations of the value of mathematics to one's future goals. In a similar vein, attitude towards mathematics has been considered as multidimensional (Hart, 1989; Ma & Kishor, 1997) distinguished by a number of dichotomies: whether one likes or dislikes mathematics; believing that one is proficient or inefficient in mathematics; the tendency to pursue or to avoid mathematics; beliefs that mathematics is significant or non-significant, easy or hard, (Ashcraft, 2002; Ma & Kishor, 1997; Neale, 1969); and whether it is engaging or uninspiring (McLeod, 1992). These pairings differ in the degree of emotionality or cognition associated with them and it is viable that an individual might have a positive attitude in relation to some yet a negative attitude in relation to others.

Researchers have tried to understand the relationship between attitude towards mathematics and mathematics achievement for many years (Ma & Kishor, 1997; Nicolaidou & Philippou, 2003). In Ma and Kishor's(1997) meta-analytic study, they observed a significant, but weak causal relationship between the two constructs. In agreement with Ma and Kishor's (1997) study, Singh, Granville, and Dika (2002) found that among Grade 8 students from the Longitudinal Study of American Youth database, achievement in mathematics was positively affected by a positive attitude towards mathematics. Similar results have been reported by Mato and de la Torre (2010), Nicolaidou and Philippou (2003) and Thomson, Hillman, and Wernert (2012). However, Chagwiza, Mutambara, Tatira, and Nyaumwe (2013) failed to find any significant relationship between attitude towards mathematics and achievement in mathematics for secondary school students from three urban schools in Bindura, Zimbabwe. The complexity of the construct of attitude to mathematics and the inconsistency in its definitions across studies make it difficult to give a conclusive picture regarding the nature of the relationship.

It has been observed that mathematical attitudes and beliefs of students tend to change gradually as the students progress through schooling (McLeod, 1992). Researchers have reported that most middle school students like mathematics, and had more positive beliefs about importance of mathematics than their high school counterparts (National Center for Education Statistics, 2001; Dossey, Mullis, Linquist, & Chambers, 1988). Wilkins and Ma (2003) using the Longitudinal Study of American Youth (LSAY) data found that secondary school students' attitudes towards mathematics becomes increasingly negative as they transit from elementary to secondary education.

Although the research studies carried out with Western and East Asian samples have found a positive relationship between the constructs, it is still unclear whether these findings are applicable in the Indian setting. Thus, this study looks at the influence of attitude to mathematics on mathematics achievement among secondary school students in India.

2.4 Parental involvement

From an early age children engage in learning and parents are their first teachers. Parental involvement describes the participation of parents in the education of children usually with the intention of enhancing their social and academic achievement (Fishel & Raimirez, 2005). Parental involvement has been among the factors that have been studied in relation to academic achievement of students in general and in mathematics in particular. The multidimensional nature of parental involvement has also been recognised by researchers (Chen & Gregory, 2010; Epstein, 1992; Grolnick & Slowiaczek, 1994) as the construct includes various parental practices and behaviours (Brown, 1994; Chen & Gregory, 2010; Epstein, 1995).

Salient aspects of parental involvement include parental encouragement of academic success (Chen & Gregory, 2010), parental expectations of academic performance (Chen & Gregory, 2010; Jeynes, 2005), participation in parent-teacher interviews, and checking of children's homework (Steinberg, Lamborn, Dornbusch, & Darling, 1992), and parenting style (Jeynes, 2005; Steinberg et al., 1992). Studies have found that parental involvement influences students' achievement throughout the school years K-12 (Simon, 2001; Trusty, 1999). Wheeler (1992) argued that parental involvement at the middle school and secondary school level is critical for teenagers to become stable and productive adults. In the same vein, Bronstein, Ginsburg, and Herrera (2005) argued that parents' day to day engagement with their children, encouraging skills in problem solving and independent thinking may further heighten achievement and motivate them toward academic success. The importance of parental involvement in children's lives has also been pointed out by Epstein (1992), who stated that students will be more interested in academic work and will exhibit more positive attitudes and other positive behaviours, and will have higher aspirations, if their parents are knowledgeable about and encouraging and involved in the education of their children.

More recent conceptualisations of parental involvement encompass activities and engagement between children and their parents at home as well as in school such as helping them with homework, supervision, and discussion about school activities (Jeynes, 2005; Pomerantz, Moorman, & Litwack, 2007). The large body of research available on how parents are involved in the education of their children, particularly in mathematics learning has shown that home-based involvement activities such as parental encouragement in child's learning, and communication between parent and child were all linked with higher achievement in mathematics (X. Fan & Chen, 2001; Jeynes, 2005). Although there exists enough evidence about the positive influence of parental involvement on mathematics achievement, findings are inconclusive about how this happens. For example, Hoover-Dempsey and Sandler (1995) suggested that parental involvement influences achievement by enhancing students' social and academic self-efficacy and motivation to learn. According to Grolnick, Ryan, and Deci (1991), parental involvement influences children's learning behaviours which in turn enhance their achievement in mathematics. Based on the literature on parental involvement, the significant parental involvement dimensions considered in the study include parental expectations, parents' encouragement of academic success, and parent participation in activities related to school (Chen & Gregory, 2010).

In their meta-analysis of studies of parental involvement, X. Fan and Chen (2001) found a significant overall positive relationship between parental involvement and academic achievement with the strongest relationship observed between parental expectations and academic achievement. This study mirrored the findings of others (e.g., X. Fan, 2001; Ma, 2001; Trivette & Anderson, 1995; Yenug, Linver, & Brooks-Gunn,

2002) who found a strong association between academic performance and parental expectations of, or aspirations for, their child's academic success. Jacobs and Harvey (2005) investigated the extent to which parental attitude and expectations of their children's academic achievement predicted achievement of students in nine secondary schools in Melbourne, Australia. Based on the final year secondary school achievement scores of students and school improvement indices, the schools were categorised into high achieving, medium achieving, and low achieving schools. The researchers investigated the degree to which parent's attitudes to school environment and academic achievement of their children influenced student's achievement in the three groups of schools. That is, they studied variables in the whole school context and compared schools rather than individual students. It was found that parents' expectations of the educational attainment of their children strongly predicted academic achievement of the students. The researchers also observed that higher expectations of their child's academic achievement had been maintained more consistently by parents from the high achieving schools since their child's birth, than had those of children at medium or low achieving schools. Chen and Gregory (2010) in their study of low achieving Year 9 students in the United States found that those students whose parents held higher expectations about their child's academic attainment and grades, performed better. Similarly, Jeynes (2007) found a strong relationship between parental expectations and academic achievement in her meta-analysis involving 300,000 secondary school students, reflecting the findings of the studies reported above.

Adolescence is a time when teenagers place more emphasis on their relationship with friends than with their family (Santrock & Yussen, 1984). In spite of this tendency, research has shown that the academic encouragement given by parents is more influential in their academic endeavours than is the support of their peers (Sands & Plunkett, 2005).

Chen and Gregory (2010) also found that parental encouragement of academic success for their child was associated with improved performance. Similarly, Catsambis (2001) found that, for Year 12 students, parental encouragement to pursue higher education was positively related to students' outcomes in mathematics, English, and science. On the other hand, when exploring the association of parental involvement and mathematics achievement among elementary school students, El Nokali, Bachman, and Votruba-Drzal (2010) found no significant association between the variables.

Parental involvement with homework has not been found to have a consistently positive influence on the academic achievement of students (E.-S. Ho & Wilms, 1996; Jeynes, 2007; T. Z. Keith & Keith, 1993; Muller, 1998). For example, T. Z. Keith and Keith (1993) found that time spent on homework was strongly associated with parental involvement defined in terms of communication between parent and child, parental aspirations for their child's education, participation in school activities and home structure, which in turn result in improved achievement. Nevertheless, some researchers have found contradictory findings in the relationship between the variables (Chen & Gregory, 2010; Ginsburg & Bronstein, 1993; I. Levin et al., 1997; Patall, Cooper, & Robinson, 2008). For example, Patall, Cooper, and Robinson (2008) found a negative relationship between parental involvement in homework and mathematics achievement in their meta-analysis of correlational studies. On the other hand, Chen and Gregory (2010) found that parental involvement in terms of parents helping with homework was not related to improved academic achievement.

Researchers have studied the influence of parenting style on the academic achievement of children and adolescents for decades (Baumrind, 1991; Dornbusch, Ritter, Leiderman, Robert, & Fraleigh, 1987; Steinberg et al., 1992; Strage & Brandt, 1999). Parenting style is a global construct (Darling & Steinberg, 1993) that encompasses the entire emotional spirit of the parent-child relationship. According to Maccoby and Martin (1983), it captures two important aspects of parenting: parental responsiveness (also referred to as parental warmth) and parental demandingness (also referred to as behavioural control). Parental responsiveness refers to "the extent to which parents intentionally foster individuality, self-regulation, and self-assertion by attuned, supportive, and acquiescent to children's special needs and demands" (Baumrind, 1991, p.62). Parental demandingness refers to "the claims parents make on children to become integrated into the family whole, by their maturity demands, supervision, disciplinary efforts and willingness to confront the child who disobeys" (Baumrind, 1991, p.61-62).

Based on extensive studies Baumrind (1971, 1978, 1991) proposed three primary parental typologies: permissive, authoritative, and authoritarian. Baumrind (1978) suggested that permissive parents are demonstrating non-controlling behaviours, using minimal punishment, are moderate in responsiveness to their children's needs and overly lax in maturity demands. They showed high levels of demandingness and low levels of maturity demands and control (Maccoby & Martin, 1983). Baumrind (1978) proposed that authoritative parents are responsive, warm, nurturing with reasonable control, affectionate, supportive of their children's academic and non-academic endeavours, and encouraging autonomy. They foster high maturity demands in their children through communication, explanation, and granting independence. Maccoby and Martin (1983) found that authoritative parents showed high levels of warmth, responsiveness, control, and maturity demands. Authoritarian parents, on the other hand, are neither warm nor responsive, but are demanding, directive, and exhibit high levels of control (Baumrind, 1978). They showed high levels of and maturity demands and control, but low levels of warmth and responsiveness (Maccoby & Martin, 1983).

Numerous studies have reported a positive association between authoritative parenting and academic performance among children and adolescents (Baumrind, 1978; Ingoldby, Schvaneveldt, Supple, & Bush, 2003; Reitman et al., 2002). Strage and Brandt (1999) studied the influence of parenting styles on college students' academic success. They found a continuing effect of authoritative parenting on students' academic performance. E. A. Turner, Chandler, and Heffer (2009) investigated the relation between parenting styles, academic performance, self-efficacy and achievement motivation among college students. Among a sample of undergraduate psychology students in the United States, they found that authoritative parenting style strongly predicted the academic performance of the students. A study investigating the long term relation between authoritative parenting and academic achievement using a sample of 10-16 year olds found that authoritative parenting facilitates students' academic success (Steinberg et al., 1989). Aye, Lau, and Nie (2008) looked at the mediating effect of self-efficacy, and task value (i.e., degree to which one believe that an academic task is worth pursuing) in the relationship between authoritative parenting and student outcomes for Year 9 students in secondary schools in Singapore. The researchers found no direct relationship between authoritative parenting and mathematics achievement, but an indirect relationship through the mediating effect of self-efficacy.

There is only limited research available on the topic of parental involvement in India, particularly in relation to mathematics achievement. Hemalatha and Sabitha (2009) studied how parental involvement influenced academic achievement of secondary school students in Kerala, South India. They found that parental involvement was not significantly associated with academic performance of the students. However, Schneider and Lee (1990) observed that East Asian parents in the United States maintain greater interest, monitor more and keep greater control over their children's education than do other parents in the United States. In a similar vein, children of Indian immigrants in the

United States have been shown to have great concern regarding their parents' expectations of their achievement compared to other children in the United States (Asher, 2002) and, like East Asian children, they believe that hard work and good performance in examinations is important for their future success (Kim, 1993). This was also true in the case of Indian students (Ramalingam, 2005; Verma & Gupta, 1990). The Indian children may have felt pressured to live up to their parents' expectations because of the personal and professional sacrifices made by parents for their education (Liu, 1998). Bearing in mind these considerations, the purpose of the present study was to confirm whether these findings based on mainly samples from Western countries are applicable to Indian students.

2.5 Influence of gender

Gender differences in educational achievement, affect, and attitudes have been researched widely because of the under representation of women in courses or careers involving advanced mathematics (Else-Quest, Hyde, & Linn, 2010; Halpern et al., 2007). According to Spelke (2005), there is no gender difference in the development of number concepts among infants and pre-schoolers. Gender differences in mathematics favouring boys tend to appear in high school years (Hyde, Fennema, & Lamon, 1990; Ma, 2008; Mullis, Martin, Fierros, Goldberg, & Stemler, 2000; Randhawa, 1991).

Pinar (2011) studied differences in the mathematics performance of a sample of 8^{th} grade students in public schools in the United States across gender as well as race/ethnicity using the data from National Assessment of Educational Progress (NAEP) 8^{th} Grade Mathematics Assessment for 2003-2007. A small gender gap, favouring boys was found. Other studies involving specific cohorts of students have reported large gender gaps in the achievement in mathematics of high ability students. For example, studies involving samples of students in gifted and talented programs found a substantial gender gap favouring high performing boys (Benbow & Minor, 1986; X. Fan, Chen, & Matsumoto, 1997; Gallagher & DeLisi, 1994). Some evidence suggests that gender performance differs with respect to the various concepts and complexity of mathematics. For example, Fennema, Carpenter, Jacob, Frank, and Levi (1998) found no gender differences among Grade 1 to Grade 3 students in their basic computational skills, but with respect to the strategies employed in solving problems, substantial gender differences were observed. According to Willingham and Cole (1997), girls in the United States showed a slight advantage in computational skills during elementary grades, whereas in problem solving and mathematical concepts, boys showed small advantage during higher elementary and secondary grades.

In a recent study in Australia, Forgasz and Hill (2013) investigated the effects of selected factors on the mathematics achievement of Grade 12 high achieving students in Victoria. The researchers considered how gender, public versus private schools, single-sex versus co-educational schools and the locality of school influenced the performance of Grade 12 students in three mathematics courses (i.e., further mathematics, mathematics methods, and specialist mathematics) in the Victorian Certificate of Education (VCE). The researchers reported that male students dominated among the high achievers in all the three mathematics courses for the period 2007-2009. In relation to younger Australian students , the National Program for Literacy and Numeracy (NAPLAN) data for Years 3, 5, 7 and 9 have revealed consistent gender gap favouring males, on average, for 2008-2010 (Forgasz & Hill, 2013). In the Programme for International Student Assessment (PISA) 2012, boys outperformed girls in mathematics in more than half of the participating countries and economies, and the performance of girls was better than that of boys in five of the participating countries (OECD, 2014).

2.5.1 Gender differences in mathematics anxiety and attitude towards mathematics

Gender differences in mathematics anxiety and the attitudes towards mathematics have been widely researched, but the findings have been inconsistent. Else-Quest et al. (2010) conducted a meta-analysis of two international data sets - the Programme for International Student Assessment (PISA) 2003 and the Trends in International Mathematics and Science Study (TIMSS) 2003 - to estimate the magnitude of gender differences in affect and attitudes. This study involved 493,495 students of 14-16 years of age from 69 nations. Despite similarities in achievement, the study reported boys as having more positive mathematics attitudes than girls. Meta analytic studies of gender differences in attitudes towards mathematics in the United States have also reported that boys have more positive attitudes to mathematics than do girls, though the gap is small (Hyde, Fennema, Ryan, Frost, & Hopp, 1990). In a similar line of research, Barkatsas, Gialamas, and Kasimatis (2008) examined students' attitudes towards computers and its interaction with mathematics achievement and gender among Year 9 and Year 10 students in Athens, Greece. The researchers observed that boys reported more positive attitudes towards mathematics and more positive views towards the use of computers in mathematics learning than did girls. On the other hand, there are studies that have reported no significant gender differences in mathematics attitudes among elementary and secondary students (e.g., Ma & Kishor, 1997; Nicolaidou & Philippou, 2003).

In terms of gender differences in mathematics anxiety, several studies have reported girls having more anxiety and lower self-concept about mathematics than boys (e.g., Fredricks & Eccles, 2002; Haynes, Mullins, & Stein, 2004; H. Z. Ho et al., 2000; Hopko, 2003; Pajares & Miller, 1994; Tapia, 2004). For samples in the United States, secondary school and college going female students were found to demonstrate more anxiety in mathematics than did males (Bernstein, Reilly, & Cote-Bonanno, 1992; Campbell & Evans, 1997). Baloglu and Koack (2006) studied multi-variate differences in mathematics anxiety among college students in Turkey. They found female students to have higher test anxiety in mathematics than males. The 2012 Programme for International Student Assessment (PISA) reported that, overall, girls had higher mathematics anxiety than boys (OECD, 2014). In an Indian study exploring anxiety among adolescents aged between 13 and 17 years, researchers found that, on average, boys experienced more anxiety than girls (Deb, Chatterjee, & Walsh, 2010). The study compared anxiety among higher secondary school students based on gender using self-reported semi-structured questionnaires. But when looking at the gender differences in mathematics anxiety among secondary school students in three different states in India (Karnataka, Kerala and Tamilnadu), Venkatsh and Karimi (2010) found that girls reported more anxiety in mathematics than the boys. In contrast, some other studies have failed to find any gender differences in mathematics anxiety (e.g., Birgin, Baloglu, Cathoglu, & Gurbuz, 2010; Cooper & Robinson, 1991). The results have thus been mixed and therefore inconclusive. Thus there is uncertainty about the association of gender and mathematics anxiety among Indian secondary school students, and so the present study investigated how gender influences students' mathematics anxiety in the Indian context.

Very little empirical evidence exists on gender differences in attitude towards mathematics among Indian students. When reviewing gender studies in attitudes to mathematics in the Asian context, the results were found to be inconsistent. For example, Mahad, Abdullah, and Abdul Kadir (2012) examined attitudes towards the learning of mathematics among 95 students enrolled in the A-level medicine (ALM) programme in the University Teknologi MARA (UiTM) in Malaysia and found that girls had more positive attitudes towards mathematics than did boys. Similar results were observed by Anwer, Iqubal, and Harrison (2012) in a study carried out in Pakistan to understand attitude towards science among Grade 10 students. They have found that girls have more positive attitude towards science compared to boys. The results were similar for the total scale- Test of Science Related Attitudes (TOSRA) - and for all the subscales of TOSRA except for Career interest in science scale. In contrast with this finding, Rodrigues and Khaliq (2012) found that male students had more positive attitude towards mathematics than their female counterparts. In the Programme for International Student Assessment (PISA) 2012, girls were reported to have less positive attitude towards mathematics than boys (OECD, 2014). However, other researchers have found no gender differences in attitude towards mathematics (e.g., Farooq & Shah, 2008; Mohammed & Waheed, 2011). Given the inconsistent picture of gender differences in the literature, the present study investigated the extent to which gender affects attitude towards mathematics among Indian students.

2.5.2 Parental involvement and gender

Not much is known about gender differences in parental involvement, especially among secondary school students in India. Early studies on parental involvement in the United States reported parents being more involved with sons in school activities, and more involved with daughters in home activities; with more involvement in total reported with daughters on average (e.g., Stevenson & Baker, 1987). Later studies in United States have found that parents were more involved in school related issues with their daughters than with their sons (Carter & Wojtkiewicz, 2000). Other studies in western countries have also reported greater involvement of parents in the education of their daughters than their sons (e.g., Fehrmann, Keith, & Reimers, 1987; P. Keith & Lichtman, 1994). The above studies portrayed parents as having more verbal communications with daughters, but showing more academic supervision of their sons. In Japan, Schoolland (1990), found parents had higher expectations for sons than daughters. Similar results were observed by Verma and Gupta (1990) for Indian students.

This section discussed gender differences in academic achievement, attitude, anxiety and parental involvement with special reference to mathematics. The majority of the studies reviewed were carried out in western settings (e.g., Else-Quest, Hyde, & Linn, 2010; Forgasz & Hill, 2013; Pinar, 2011), and a few of them were conducted with students in Asian countries (e.g., Mahad et al., 2012; Schoolland, 1990; Verma & Gupta, 1990). Based on the few studies available, it appears that parental involvement and gender associations might vary among countries and over time. A new study of these relationships involving Indian students will add to the existing knowledge.

2.6 Summary

This chapter provided a review of the literature related to mathematics anxiety, attitude towards mathematics, and parental involvement and their influence on mathematics achievement. The review has shown that mathematics anxiety negatively influences achievement in mathematics. That is, students with higher mathematics anxiety perform more poorly in mathematics than their less anxious peers (H. Z. Ho et al., 2000; Woodard, 2004). The relationship between attitude towards mathematics and achievement in mathematics is inconclusive because of the complex nature of the construct, although a positive relationship has been observed between the two variables in general (Nicolaidou & Philippou, 2003; Singh et al., 2002). Parental involvement has been found to influence the academic achievement of students from kindergarten to Year 12 (Simon, 2001). In particular, parental expectations have been found to have the strongest influence on the mathematics achievement of students (X. Fan & Chen, 2001; Ma, 2001; Trivette & Anderson, 1995).

Gender differences in mathematics anxiety, attitude towards mathematics, parental involvement, and mathematics achievement has also been widely researched. In terms of mathematics anxiety of male and female students, researchers have found female students to have more mathematics anxiety than their male counterparts (Haynes, Mullins, & Stein, 2004; Hopko, 2003). Other researchers have reported male students having more mathematics anxiety than female students (Deb, Chatterjee, & Walsh, 2010). Studies examining gender differences in attitude towards mathematics have reported boys having more positive attitude to mathematics than girls (Else-Quest et al., 2010; Hyde, Fennema, Ryan, et al., 1990). Results concerning gender differences related to parental involvement in mathematics are inconsistent. For example, some researchers found that parents were more involved with boys than girls (e.g., Schoolland, 1990; Verma & Gupta, 1990), others found that parents were more involved with girls than boys (e.g., T. Z. Keith et al., 1998). These findings are likely related to the varied definitions of parental involvement and the multi-faceted nature of the construct.

The present study explored how mathematics anxiety, attitude towards mathematics and parental involvement influences the mathematics achievement of secondary school students in India. In the present study it was hypothesised that mathematics anxiety, attitude towards mathematics and parental involvement would have a direct influence on mathematics achievement of students. Further, it was expected that parental involvement would directly influence mathematics anxiety and attitude towards mathematics and it also assumed a correlational relationship between mathematics anxiety and attitude towards mathematics. Furthermore, the study investigated the influence of gender on these variables. The methodology adopted for the study is described in the next chapter, Chapter 3, along with the discussion of the sample, the instruments used and the procedures for data collection.

CHAPTER 3 METHODOLOGY

3.1 Introduction

A mixed method approach using a cross sectional research design was employed in this study. Mixed method research involves collection and analysis of both quantitative and qualitative data (Creswell, 2003). The quantitative data consisted of closed-ended information from the participants collected through questionnaires, whereas the qualitative data comprised open-ended responses collected through interviews. This chapter describes the research design for the study, the instruments, the sample, and the data collection procedures. The data analysis procedures are described in Chapter 4.

3.2 Research Design

The research design was selected and developed on the basis of the conceptual model of the study, shown in Figure 3.1. The study aimed to investigate the relationship among the variables mathematics anxiety, attitude towards mathematics, parental involvement and mathematics achievement at a particular point in time and for a particular group of participants. Thus, a mixed method approach with cross sectional research design was the appropriate method for the study. Mixed methods approaches apply various strategies of inquiry that help the researcher to collect data either simultaneously or in sequence to better understand the problem under study (Creswell, 2003). Further, this approach enables the researcher to conduct the data collection procedures in the natural environment of the school or home for the participants (Lin, 1976). The cross-sectional research design enables the researcher to understand the prevalence of a particular attribute for a population or a sample of the population at one point in time

(K. A. Levin, 2006).

3.3 Conceptual model

The conceptual model built on the literature review findings discussed in the introduction chapter is shown in Figure 3.1. The variables, mathematics anxiety, attitude towards mathematics, and parental involvement were included in the model. These variables were hypothesised to influence mathematics achievement among secondary school students as in Figure 3.1. The study also investigated the inter-relationships among the variables and the influence of gender on these variables.

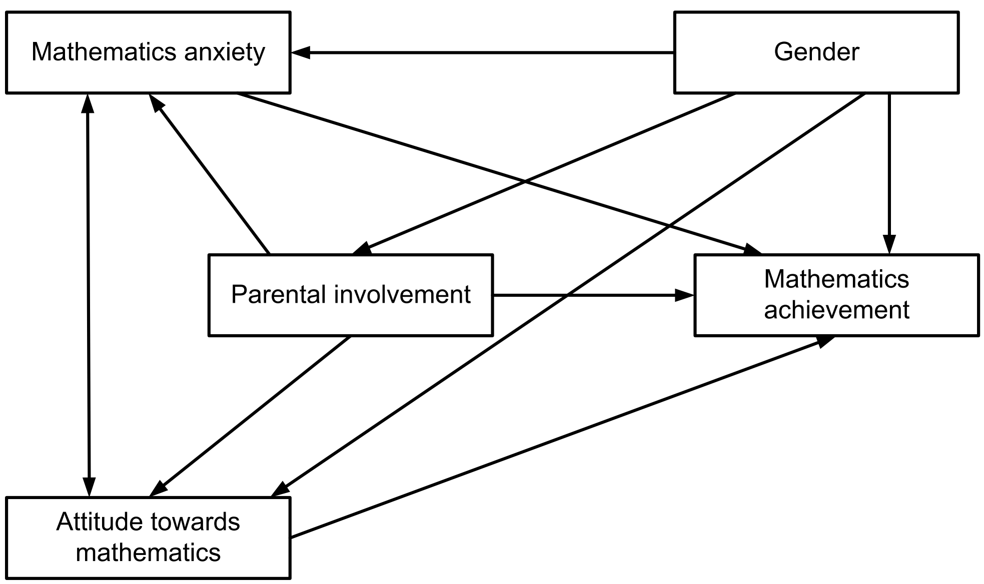


Figure 3.1. Conceptual model for the study showing the relationship between the variables

The research questions that framed the study were based on the conceptual model. They were:

1. How does parental involvement in learning influence mathematics achievement of

secondary school students in India?

2. How does attitude towards mathematics influence mathematics achievement of secondary school students in India?

3. How does mathematics anxiety influence mathematics achievement of secondary school students in India?

4. How do parental involvement, attitude towards mathematics and mathematics anxiety interact to influence the mathematics achievement of secondary school students in India?

5. Are there gender differences in relation to any of these variables and/or their relationships?

3.4 Data collection tools

The next section explains the general characteristics of questionnaires and interviews used for collecting quantitative and qualitative data.

3.4.1 Questionnaires

A questionnaire is a list of questions used to collect information from a large number of people on the subject of interest. It serves as a medium through which the researcher and the respondent communicate indirectly (Brace, 2004). According to Strange and his colleagues (Strange, Forest, Oakley, & The Ripple Study Team, 2003), respondents may feel more comfortable to convey their opinions through questionnaire than in a face-to-face interview.

Questionnaires have various other advantages and disadvantages. They are cost effective, and convenient to administer (Cohen & Manion, 1994) and are supposed to be less invasive than face-to-face interviews (Popper, 2002) and are also considered an inexpensive way to cover large geographical areas. The main disadvantages include low response rates, the inability to clarify misunderstandings or doubts of the respondents (Fox, Murray, & Warm, 2003). In the case of postal or web-based questionnaires, the researchers do not have any control over the person who completes the questionnaire (Neuman, 2001).

3.4.2 Interviews

Interviews can be used to describe and understand the experiences of the interviewee (Kvale, 1996). They can be used as a follow up from a questionnaire to look further into the responses of the subjects (McNamara, 1999). Interviews have been categorised as unstructured, semi-structured, or structured interview (Bernard, 1988; Fontana & Frey, 2005; Crabtree & Miller, 1999). In an unstructured interview, the interviewee has the freedom to talk freely to the interviewer's question (Bryman & Bell, 2007). The unstructured interview is more casual and flexible and the interviewee can express their views freely. Semi-structured interviews are usually planned in advance for an allotted time, at an allotted place. They are coordinated around a set of pre-planned questions and the remaining questions come out of the conversation between the interviewer and the interviewee (Dicicco-Bloom & Crabtree, 2006). In semi-structured interviews, all the participants are asked identical questions formatted in such a way that the responses were open-ended (Gall, Gall, & Borg, 2003). In this type of interview, the interviewer can adjust the order of the questions based on respondents' answers and dig deeper into a given situation.

The time required to code interview data is arguably the main disadvantage associated with the semi-structured interview (Creswell, 2003). Because the composition of the open-ended questions allows the respondent to give their responses in detail, it can be difficult for the researcher to identify similar codes from the transcripts of the interviews. Another disadvantage in a semi-structured interview is that the follow-up questions depend on the responses of the interviewee and hence vary from participant to participant. Other disadvantages of semi-structured interviews include the length of time required to conduct the interviews and interviewer bias. In a structured interview there is a pre-determined set of questions which are to be covered within the set time (Bryman & Bell, 2007).

3.5 Instruments

The details of the instruments used in the study are explained in the following sections. The instruments included a student questionnaire, a questionnaire for a parent, and a student achievement test in mathematics. The first section details the sources of the questionnaire instruments used, and the second describes the interview schedules. It was out of the scope of this thesis to describe all the instruments used to measure the variables of interest in previous studies.

3.5.1 Questionnaires

This section begins with a description of existing instruments that were used as the basis for the questionnaires in the current study. Subsequent sections describe the actual instruments that were used.

3.5.1.1 Existing questionnaire instruments.

3.5.1.1.1 Shortened Form of the Fennema-Sherman Attitudes Scales.

The Fennema-Sherman Attitudes Scales (FSMAS) (Fennema & Sherman, 1976) were formulated to study gender differences among secondary school students in relation to affective factors relevant to achievement in mathematics (Mulhern & Rae, 1998). There were nine scales in the FSMAS instrument: Attitude Towards Success in Mathematics scale; Mathematics as a Male Domain scale; Mother, Father, and Teacher scales; Confidence in Learning Mathematics scale; Mathematics Anxiety scale; Effectance Motivation in Mathematics scale; and Usefulness of Mathematics scale, containing 12 items each. The Cronbach alpha coefficients of the individual scales ranged from 0.87 to 0.93.

Mulhern and Rae (1998) developed a shorter version of the Fennema-Sherman Attitudes Scale and validated it with a sample of 196 school children from the Republic of Ireland. The seven scales in the Shortened Form of the Fennema-Sherman Attitudes Scales (FSMAS) are Attitude Towards Success in Mathematics scale; Mathematics as a Male Domain scale, Mathematics Anxiety scale, Mother, Father and Teacher scale, Confidence in Learning Mathematics scale, Usefulness of Mathematics and Effectance Motivation in Mathematics scale, with 12 items each.

The Mulhern and Rae study reported a Cronbach alpha coefficient of 0.93 for the whole scale and the individual scales were reported to have alpha coefficients ranging from 0.79 to 0.93. These scales have been used individually (Drisko, 1993), in a set of two or more (Iben, 1991), or as a complete scale (Sherman, 1982). Researchers have modified and used the FSMAS for different subject areas (Lirgg, 1993; Sticker, Rock, & Burton, 1993) and for various age groups (Elliot, 1990; Sherman, 1983). The present study used the Attitude Towards Success in Mathematics scale; Mathematics Anxiety scale; Parent scale (adapted from Mother, Father and Teacher scales); Confidence in Learning Mathematics scale; Usefulness of Mathematics, and Effectance Motivation in Mathematics scale from the Mulhern and Rae study to measure the constructs attitude towards mathematics, mathematics anxiety, and parental involvement.

3.5.1.1.2 Parental Authority Questionnaire.

The Parental Authority Questionnaire (PAQ) (Buri, 1991) was developed to measure the three prototypes of parental authority; authoritarian, authoritative and permissive as proposed by Baumrind (1971). The scale items were designed to measure parenting style as perceived by the sons and daughters (Buri, 1991). The PAQ as a single scale was based on the conceptualisation of parenting style on a continuum of most controlling to least controlling. PAQ consisted of 30 items; 10 items each to measure authoritarian parenting style, authoritative parenting style, and permissive parenting style. There were two forms of the Parental Authority Questionnaire- one form to assess a father's parental authority and the other to assess a mother's parental authority. A 5-point Likert scale was used to collect responses from participants.

The test-retest reliability coefficients and Cronbach alpha values for the six PAQ scales from the Buri study were highly respectable; 0.81 and 0.75 for mother's permissiveness, 0.86 and 0.85 for mother's authoritarianism, 0.78 and 0.82 for mother's authoritativeness, 0.77 and 0.74 for father's permissiveness, 0.85 and 0.87 for father's authoritarianism, 0.92 and 0.85 for father's authoritativeness.

3.5.1.2 Existing achievement test instruments.

3.5.1.2.1 Programme for International Student Assessment.

The Programme for International Student Assessment (PISA) is an initiative of the

Organisation for Economic Co-operation and Development (OCED) to keep track of the educational outcomes of the member countries. The PISA 2009 assessment in mathematics covered various overarching ideas: quantity, space and shape, change and relationships and uncertainty. The assessment was being carried out under a commonly agreed international framework in terms of student achievement. PISA is an internationally standardised assessment tool for 15-year-old students in school and work-based programmes (PISA, 2009). It assesses student's content knowledge in the areas of reading, mathematics and science as well as their skills in applying their knowledge to new life situations. PISA also provides information about family's, social, economic, and cultural background, school, learning styles, skills, and attitudes. PISA therefore, helps in understanding the interaction between student outcomes, home, and school, thereby contributing to policy making and implementation with a view to improve student outcomes. Experts from participating countries ensure the international validity of the PISA instruments, taking into account the differing curricular and cultural setting of the participating countries. The study was intended to be positioned in an international context. PISA was selected as the achievement test instrument because it is an internationally standardised assessment tool used widely in the international context.

3.6 Instruments for the present study

3.6.1 Student questionnaire

The student questionnaire was adapted from the Shortened Form of Fennema-Sherman Attitudes Scales (Mulhern & Rae, 1998) and Parental Authority Questionnaire (Buri, 1991). It consisted of eight scales measuring the constructs, attitude towards mathematics, mathematics anxiety, and parental involvement. The two scales measuring attitude towards mathematics were the Attitude towards maths and success in mathematics (sattitude) scale and the Usefulness of mathematics (susefulness) scale. The three scales measuring mathematics anxiety were the Anxiety (sanxiety) scale, the Confidence in learning mathematics (sconfidence) scale, and the Effectance motivation in mathematics (smotivation) scale. The three scales measuring parental involvement were the Parent behaviour (sparentbeh) scale, the Parent attitudes (sparentattitude) scale, and the Parenting style (sparsty) scale. The complete student questionnaire is included in Appendix A. The students were asked to rate their agreement with each of the statements in the questionnaire on a 5-point scale with choices comprising Strongly Disagree, Disagree, Undecided, Agree, and Strongly Agree. The items were coded so that higher scores indicated greater measure of the construct.

Some of the items were reworded for the present study to make the statements clearer to the respondents. Some examples of items that were reworded for use in the student questionnaire are given in Table 3.1. The positively worded item 'I can get good grades in mathematics' in the confidence in learning mathematics (sconfidence) scale was reworded to 'I am sure I could get good grades in maths' to affirm the positive nature of the item. The phrase 'uneasy and confused' in the next item was replaced by the word 'confused' to give the statement more clarity. As either the student's father or mother was asked to respond to the parent questionnaire, the word 'mother' was replaced by 'parents'. The word 'do' was replaced by 'score' for clarity in the last item as the word 'do' might be interpreted by the students as doing class work, instead of their achievement scores.

Table 3.1

Example of reworded items in the student questionnaire

Items	Reworded Items
I can good grades in mathematics	I am sure I could get good grades in mathematics
Mathematics makes me feel uneasy and confused	Mathematics makes me feel confused
My mother has encouraged me to do well in mathematics	My parents encourage me to score well in mathematics

The negatively worded items in the student questionnaire were reverse coded. For example, the negatively worded items in the attitude towards maths and success in mathematics (sattitude) scale, 'I do as little maths as possible when I get the choice' and 'If I had good grades in maths, I would try to hide it' were reverse coded. Similarly, the negatively worded items in the usefulness of mathematics (susefulness) scale, confidence in learning mathematics (sconfidence) scale, effectance motivation in mathematics (smotivation) scale, parent behaviour (sparentbeh) scale, parent attitudes (sparentattitude) scale and the remaining items in the attitude towards maths and success in mathematics (sattitude) scale were also reverse coded. Examples of the reverse coded items in the sanxiety scale and sconfidence scale are shown in Table 3.2.

Table 3.2

Example of reverse coded items in the student questionnaire

Reverse coded items
Mathematics has been my worst subject
I'm not the type to do well in maths
My mind goes blank and I am unable to think clearly while doing a maths test
I don't think I could do advanced maths
Mathematics makes me feel confused

Full details of the reworded items and the reverse coded items in the student questionnaire are provided in Appendix B.

3.6.2 Parent Questionnaire

The items in the parent questionnaire were adapted from the Shortened form of Fennema-Sherman Mathematics Attitudes Scales (Mulhern & Rae, 1998) and Parental Authority Questionnaire (Buri, 1991). The parent questionnaire consisted of five scales namely, the Parent behaviours (pparentbeh) scale, the Parent maths anxiety (panxiety) scale, the Parent attitude towards maths and child's maths study (pattitude) scale, the Parental expectations (pexpectation) scale, and the Parenting style (pparsty) scale. The complete parent questionnaire is provided in Appendix C. For the purpose of the present study some of the items in the parent questionnaire were reworded. Examples of items that were reworded for use in the parent questionnaire are given in Table 3.3.

Table 3.3

Example of reworded items in the parent questionnaire

Items	Reworded Items
I get a sinking feeling when I think of trying math problems	I usually get a sinking feeling when I try to do maths
My father thinks that mathematics is one of the most important subjects I have studied	I think that mathematics is one of the most important subjects to study
My mother thinks I'll need mathematics for what I want to do after I graduate from high school	I think that my child needs mathematics for what he/she wants to do after finishing secondary schooling

The first of these was reworded so that it could be easily understood by the respondents. The remaining two examples in Table 3.3 were reworded to change the subject in the statement, making it appropriate for a parent.

The negatively worded items in the parent questionnaire were reverse coded. For example, the negatively worded items in the parent attitude towards maths and child's maths study (pattitude) scale, 'I am not concerned whether my child takes more maths courses in future' and the item 'I think that advanced maths is a waste of time for my child' were reverse coded. Similarly, the remaining negatively worded items in the parent attitude towards maths and child's maths study (pattitude) scale, and those in the parent behaviour (pparentbeh) scale, and parent maths anxiety (panxiety) scale were also reverse coded. The reverse coded items in the parent maths anxiety (panxiety) scale are shown in Table 3.4. The questionnaire items were also validated and used in the international context.

Table 3.4

Example of reverse coded items in the panxiety scale in parent questionnaire

Reverse coded items
Mathematics usually makes me feel uncomfortable and nervous
I usually get a sinking feeling when I try to do maths
As a student, my mind goes blank and I am unable to think clearly while taking a maths test
I worry about ability to solve maths problems
Mathematics makes me feel confused
I am not concerned with the progress of my child in mathematics

Full details of the reworded items and the reverse coded items in the parent questionnaire are provided in Appendix D.

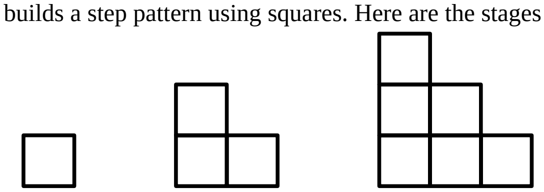
Research experts in the field of education reviewed the statements in the questionnaire for students and the parents. A pair of students of similar age to the student participants was asked to review the statements in the student questionnaire and a pair of parents was asked to review the statements in the parent questionnaire respectively and minor changes were made in the statements in both the questionnaires. Thus the face validity of the instruments was established. The study was set in the Indian context and the participants were students and parents in a private school in Kerala, India. Because the researcher lives in Tasmania, it was not feasible to conduct the field trial among Indian students.

3.6.3 Achievement test in mathematics

A 10-item multiple choice mathematics test of approximately 40 minutes duration was used to measure achievement of students in mathematics. The questions in the achievement test were selected from the publicly available items from Programme for International Student Assessment (PISA) 2009 test (PISA, 2009) based on the difficulty level. PISA is an internationally standardised assessment tool and hence valid across many countries and cultures. The questions were from the units - farms, cubes, speed of a racing car, triangles, internet relay chat, exchange rate, bookshelves, spring fair, and step pattern, with one chosen from each unit. Example of the items included in the achievement test are shown in the Figure 3.2.

Items

1. Robert builds a step pattern using squares. Here are the stages he follows.

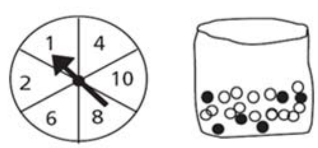


Stage 1 Stage 2 Stage 3

As you can see, he uses one square for Stage 1, three squares for Stage 2 and six for Stage 3. How many squares should he use for the fourth stage?

Answer: ---------------- squares

2. A game in a booth at a spring fair involves using a spinner first. Then, if the spinner stops on an even number, the player is allowed to pick a marble from a bag. The spinner and the marbles in the bag are represented in the diagram below.



Prizes are given when a black marble is picked. Sue plays the game once. How likely it is that Sue will win a prize?

A. Impossible. B.Not very likely. C. About 50% likely. D.Very likely E. Certain

Figure 3.2. Example of items in the achievement test

These items assessed students' mathematical competencies in relation to two of the overarching themes -change and shape; and uncertainty (statistics and probability theory)- assessed in PISA test. The achievement test in mathematics used in this study in its complete form is provided in Appendix E.

3.6.4 Interviews

For the purpose of this study, semi-structured interviews were selected, based on the fact that they allow the researcher more freedom in conducting the interview and can collect the detailed information on the topic under study by asking probing questions. Before the interviews were conducted two interview schedules were prepared: one for the students and one for the parents. Examples of the interview questions for the students and the parents are given in Figure 3.3 and Figure 3.4 respectively. The complete interview schedules for the students and the parents are provided in Appendix F.

1. Who helps you with your study?
2. What is your worst subject in school?
3. How do you rate yourself as a mathematics student?
4. How do you feel about it? Why?
5. How do you feel when taking a mathematics test?

Figure 3.3. Example of questions for the students

1. How much are you involved with your child’s schooling?
2. How do you help your child with his/her studies?
3. How often do you check his/ her home work?
4. How much are you involved with your child’ mathematics learning?
5. How do you help your child with the maths home work?

Figure 3.4. Example of questions for the parents

In the present study efforts were taken to conduct the interviews in detail and on time. In order to reduce personal bias, efforts were taken to accurately reflect the overall view of all interview responses through the coding procedure. The participants who chose to communicate in English were interviewed in English and those who preferred to be interviewed in Malayalam were interviewed in Malayalam. Further details of the interview coding are provided in Chapter 4.

3.7 Sample for the study

Data were collected from Year 9 and Year 11 students at one secondary school in Kerala, India. Parents of participating students were also invited to participate. Only Year 9 and Year 11 students and their parents were included in the study. The principal gave permission to collect data from them only because it was examination time for Year 10 and Year 12 students. The sample came from a homogeneous middle class socio-economic group. The students and parents participated in this study were living in the same geographical area and from similar social background. Majority of the parents were public servants and had similar economic status. The participating school was owned and managed by the Catholic Education Trust in the Major Archdiocese of

Trivandrum, Kerala. The school catered for classes from Lower kindergarten to Year 12, following the Central Board of Secondary Education (CBSE) syllabus. Instruction was provided in English.

3.7.1 Description of participants

A total of 220 students and their parents (one parent from each family) in Kerala were invited to participate in the study. Of these, 140 students and 120 parents consented to participate in the study. Of these, 135 students and 118 parents participated in the research study. Of the 135 students, 52 were males and 83 females, and 78 students were from Year 9 and 57 students from Year 11. Of the 118 parents, 56 were males and 62 were females. Table 3.5 shows the numbers of student participants in the study.

Table 3.5

Numbers of student participants in the study

	Male	Female	Total
Year 9	31	47	78
Year 11	21	36	57
Total	52	83	135

3.8 Interviews

All the students in Year 9 and Year 11 from the school and their parents were invited to participate in an interview. Semi-structured questions were used for the interviews representing the conceptual framework of the study. The questions were designed to gain insights that would enhance understanding of the relationships depicted in the framework.

3.9 Data Collection Procedures

This section describes the procedures used for the data collection. The data collection process was conducted from December 2011 to January 2012 in India. Ethical guidelines and policies recommended by the University of Tasmania were strictly adhered to in the study. The approval of the Tasmanian Human Research Ethics Committee was obtained for the study (see Appendix G). Permission for data collection was obtained from the principal of the school. The letter granting permission is provided in Appendix H. Teachers' consent was also received to conduct data collection in their respective classrooms. The teachers' consent form is provided in Appendix I.

3.9.1 Data collection from students

The student information sheet for the questionnaire and achievement test, parent consent form for student questionnaire and achievement test (see Appendix J and Appendix I) were sent home with the students via class teachers. An envelope addressed to the researcher, care of the school, was also included. Parents were asked to return the signed student questionnaire and achievement test consent forms, and the completed parent questionnaire, including the consent form for that instrument in an envelope addressed to the researcher. They were asked to return the sealed envelope through their child to the respective class teachers, approximately one week from the date on which the documents were sent home. The returned envelopes were collected by researcher from the class teachers.

Once the parental consent was obtained, student participants in the study were given a brief explanation of the purpose of the study in their classes by the researcher.

The students were reminded that their participation was important to the study, but voluntary. The achievement test was administered to the student participants in their respective classrooms in a scheduled mathematics lesson. The student consent form for the achievement test was included as the first page of the test. Appendix I provides the student consent form for the achievement test. Similarly, the students were administered the questionnaire in their respective classrooms in a different lesson from the one in which they completed the achievement test, but on the same day. The lessons were at least one hour apart. The decision to administer the achievement test and the student questionnaire on the same day was taken by the researcher because the principal of the school permitted only one day for data collection. The questionnaire was administered to the students in different classes during free lessons. Care was taken to keep a gap of at least one hour between the administration of the achievement test and the questionnaire. The student consent form for questionnaire was included as the first page of the questionnaire. Appendix I provides the student consent form for the questionnaire. Both the questionnaire and the achievement test were administered in English. Of the total of 140 students who consented to participate in the study, 135 (96.4%) students completed the achievement test and the questionnaire.

3.9.2 Student Interviews

The students were asked at the end of the questionnaire to indicate their willingness or otherwise to participate in the interview . A sample was selected from those who indicated their willingness for the interview based on their scores in the achievement test of the study. Based on their achievement test score the students were grouped into high, medium, and low achievers. The students whose achievement test score was equal to and above Mean+2SD were grouped as high achievers, the students whose achievement test score was equal to and below Mean-2SD were grouped as low achievers, and those students with achievement test score between Mean+2SD and Mean-2SD were grouped as medium achievers. From those who had consented to participate, four students from each of the three groups were selected at random for the interview. The parent consent form for the student interview was sent home with the selected students through the class teachers. Of the twelve students selected for the interview, only six students had parental consent to participate in this aspect of the study. Thus six student-parent pairs, two students (and their parents) from each achievement group participated in the interview. Although selected in pairs, participants were interviewed separately. The students who consented for the interview (with parent consent) were interviewed for approximately 30 minutes at their homes. In most cases parents were present while the students were interviewed because this was their preference.

The interviews started with an informal chat with the student about their interests and family to make them feel at ease. Students who chose to communicate in English were interviewed in English and those who preferred to be interviewed in Malayalam were interviewed in Malayalam. All the interviews were recorded with the students' permission using an iPhone. Parent consent forms for student interview and student interview consent forms are provided as Appendix I.

3.9.3 Data collection from parents

The parents of all students who completed the questionnaire and the achievement test in the study were sent the parent questionnaire through the students via the class teachers. It was expected that parents would have taken about 20 minutes to complete the questionnaire. The parents were asked to return the completed questionnaire to their child's class teacher in a sealed envelope addressed to the researcher for confidentiality purposes. The parents were given a week to return the questionnaire to the school with their child after which they were collected from the school by the researcher. Reminders were sent through students for non returns. Of the 120 parents who consented, 118 (98.3 %) parents participated in the study. The parent consent form for the questionnaire is provided in Appendix I.

3.9.4 Parent interviews

The parents who indicated their willingness to participate in an interview were asked to give their consent by signing the consent form (provided in Appendix I) and returning it to the school with their child. The parent (either father or mother) of the selected student interviewees was interviewed at their home straight after their child was interviewed. The parent interviews took approximately 20-30 minutes. Only on one occasion was the student participant present during the parent interview. All the interviews started with an informal chat about the family and participants' interests to put the interviewee at ease. The parents who preferred to be interviewed in English were interviewed in English and those who chose to communicate in Malayalam were interviewed in Malayalam. All the interviews were audio recorded using an iPhone.

3.10 Summary

This chapter has addressed the research design used in the study. An explanation of the instruments used for data collection for both students and parents was provided. A description of the participants and data collection procedures for both questionnaires, achievement test, and interviews was provided. The next chapter, Chapter 4, describes the data analysis approaches adopted in the study.

CHAPTER 4 DATA ANALYSIS PLAN

4.1 Introduction

This chapter describes the procedures associated with data analyses employed in the study. Descriptive and measurement analyses were used to describe the nature of student data from the student questionnaire and the achievement test, and parent data obtained from the parent questionnaire. The hypothesised relationships among the studied variables were explained using inferential data analysis techniques. The interview data were analysed using content text analysis. The chapter first describes the quantitative data analysis steps, followed by the steps in the analysis of the qualitative data obtained in the study.

4.2 Analysis of quantitative data

The data from all the measures of student and the parent questionnaires were analysed according to the analysis plan shown in Figure 4.1.

In accordance with the analysis plan, the first step was to prepare the data for analysis. The prepared student and parent data were subjected to Rasch measurement analysis separately. In the next step, the Rasch estimates for person ability were calculated for students and parents. The student and parent data were then collated and the multivariate normality was checked for further analysis. As shown in the analysis plan (Figure 4.1), Rasch analysed variables were then compared using multivariate analysis of variance (MANOVA) and the structural relationships were established using structural equation modeling.

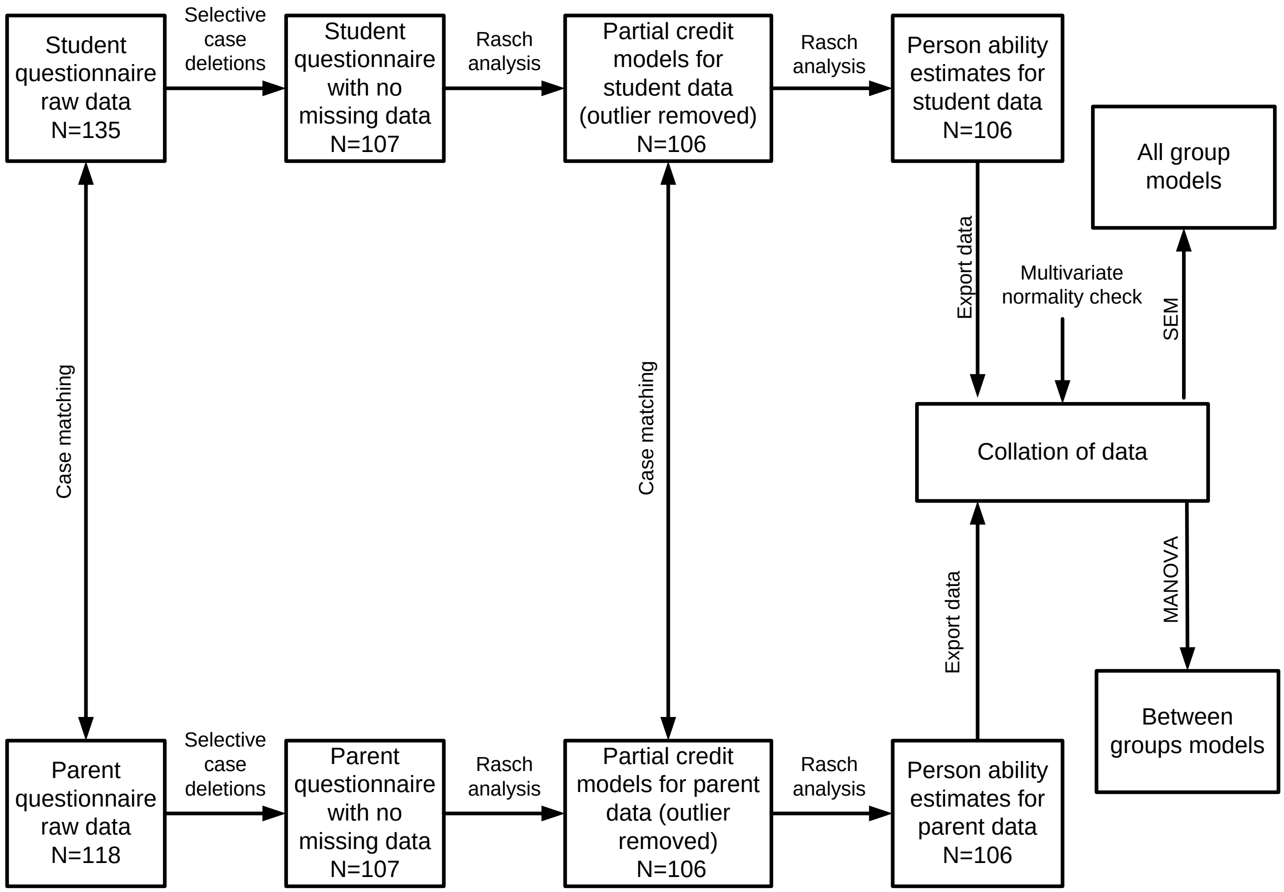


Figure 4.1. Overview of the analysis plan for quantitative data in this study

4.3 Preparation of data

The student and parent data obtained were entered into SPSS file and proofread to make sure that no errors occurred while transferring the data from paper to computer. A second round of proofreading of the data against the original was done to ensure that no errors occurred. Unmatched data (either no student data or parent data) were discarded from analysis. Using SPSS version 21.0 (IBM corp, 2012), a frequency analysis was conducted to find any missing or irregular data. A descriptive analysis was carried out using SPSS to report the sample population. All the details of these analyses are reported in the next chapter, Chapter 5. The next section of this chapter details the analysis procedures used to describe the data fit to the Rasch model and their performance.

4.4 The Rasch models

Measuring a latent trait (a complex behaviour or concept that can't be observed directly) with precision has been a crucial issue in social science research. Generally, these concepts or behaviours are measured using questionnaires, with items describing the various aspects of the trait under study. The participants indicate their level of agreement with each statement by means of raw score. Because the raw score is an ordinal measure indicating a possible measure of the latent trait, it has little inferential value, and comparisons about the latent trait under study are difficult (Bond & Fox, 2007).

The introduction of Rasch family of measurement models (Rasch, 1960, 1980; Bond & Fox, 2007) solved the problem and provided a stronger basis for comparisons. Rasch measurement models allow the researcher to produce real interval measures and the Rasch person ability estimates and the item difficulty estimates generated can be used for further statistical analysis (Bond & Fox, 2007). In the Rasch models based on the performance of persons and items, a set of measures are produced which define the position of persons and items on the same measurement scale. This provides an interval scale in units of logits, the logarithm of the odds of success (Bond & Fox, 2007). The participants' data from the student questionnaire and parent questionnaire in this study were ordinal. Rasch measurement models were used to produce interval measures allowing better comparisons and more meaningful interpretation. The Rasch modelling software Winsteps version 3.75.1 was used in this study (Linacre, 2012).

4.4.1 Partial Credit Models

The student and parent data in the present study were analysed using the Partial Credit Model (PCM) (Masters, 1982), an extended version of the Rating Scale Model (RSM) (Andrich, 1978). The study used 5-point Likert scales with the categories Strongly Disagree, Disagree, Undecided, Agree, and Strongly Agree indicating increasing amounts of ability (or agreement). The partial credit model was used to analyse all the scales in the study because all the five response categories for each item provided in the response form for the scales, might not have been used by the respondents in the chosen sample (Bond & Fox, 2007).

The PCM can be expressed as:

$$\log\left[\frac{P_{nik}}{P_{ni(k-1)}}\right] = B_n - D_{ik}$$

where

P_{nik} is the probability that person n, on encountering item i would respond in category k,

$P_{ni(k-1)}$ is the probability that response would be in the category $k-1$,

B_n is the type of attitude or ability of person n,

D_{ik} is the difficulty of item i, but re-parameterised to include threshold variation, k of item i, and where $n = 0$, (Linacre, 2004, p.259-260).

4.4.2 Assumptions of Rasch model

Rasch models are supported by three underlying assumptions. The first assumption requires that the variable under study should be a one-dimensional construct (Bond & Fox, 2007). Uni-dimensionality means that one latent trait will be measured at a time

(Bond & Fox, 2007; Mueller, 2006). The second assumption of the Rasch model is that latent variable studied is measurable by a linear measure where a greater amount of the construct is represented by greater value. Finally, the third assumption requires that the items measuring the construct are independent of each other (Bond & Fox, 2007). In other words, items should be designed in such a way that getting a later correct answer is independent of an earlier correct answer. An instrument could be an efficient measurement tool if the items comprising the instrument fulfil the above assumptions.

4.4.3 Data fit

Rasch models provide the fit statistics to test the assumption of uni-dimensionality. The fit statistics (infit and outfit statistics) indicate the extent to which the expected and observed pattern of responses match (Bond & Fox, 2007; Linacre, 2004). Rasch modelling software Winsteps (Linacre, 2012) generates fit measures for persons and items, estimates of item difficulty and person ability, and the person and item reliability indices. The steps involved in the Rasch analysis of the scales used in the study were estimations of the overall data fit along with the fit of individual scales and the calibration of person abilities and item difficulties (Bond & Fox, 2007).

Fit data were obtained by fitting the data from the instruments to the Rasch model. Well fitted data meant that the instruments used in the study satisfied the basic assumptions of the Rasch model. Items that departed from the assumptions of the model would show up in fit statistics. The item fit statistics included item infit and outfit mean squares and infit and outfit t values. Mean squares are the unstandardised form of the fit, and t values are the standardised form of the fit. The expected t value of zero and standard deviation of 1 are recommended for overall fit of the data to the model (Wright

& Stone, 1979). For misfitting items, the weighted t value was reported as the estimate of the items on a scale of -2 and +2 (Bond & Fox, 2007; Linacre, 2004). Items having infit and outfit t values of more than +2 or less than -2 are considered as poor fitting items (Bond & Fox, 2007).

4.4.4 Variable map

A variable map or Wright map provided a visual representation of the persons and items based on the level of their ability and difficulty. Both persons and items were shown on the same logit scale. The logit scale represents "an interval scale in which the intervals between the locations on the person-item map have a consistent value or meaning" (Bond & Fox, 2007, p. 318). Using the logit scale of measurement, the item difficulty was checked against person ability to understand the nature of the variables in the study. Persons were represented on the left hand side and the items at the right hand side in the map. The mean of the items and persons were represented in the map as 'M', one standard deviation as 'S', and two standard deviations as 'T'. The easiest items were located at the bottom of the scale and most difficult items at the top of the scale (Bond & Fox, 2007). Figure 4.2 shows a variable map generated by Winsteps.

The Rasch measurement model generates reliability indices that enable the researcher to understand the spread of the items and persons on the logit scale. The person reliability index provides a measure of consistency in person ordering if a parallel set of items were given to the sample to measure the same construct (Bond & Fox, 2007; Linacre, 1997). Similarly, the item reliability index provides an estimate of the consistency of the item spread in the scale, if the same set of items were administered to another sample of the same size with similar characteristics (Linacre, 1997). The person

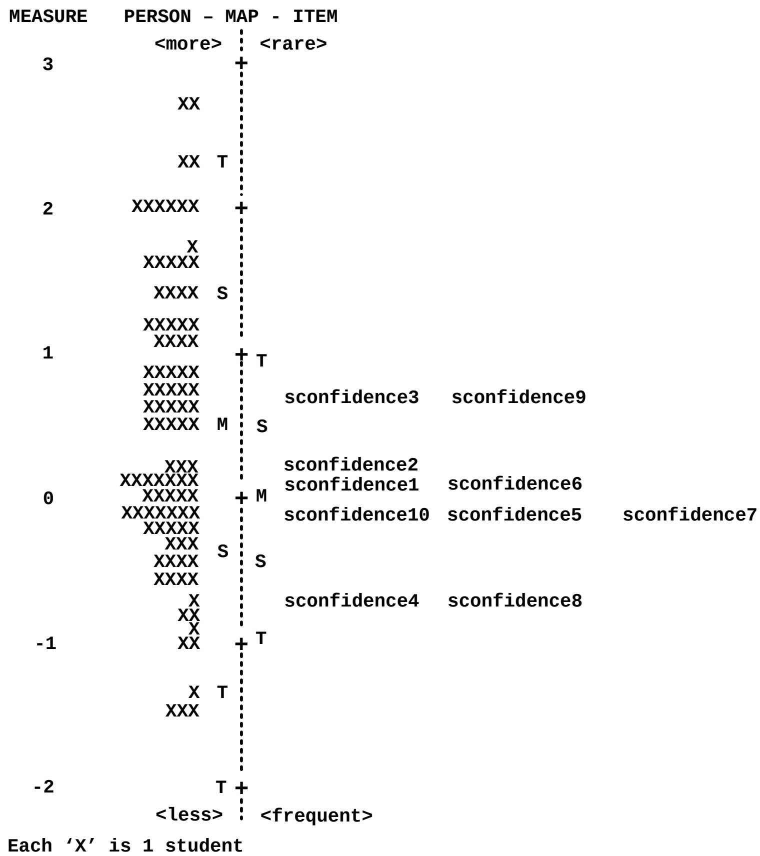


Figure 4.2. Example of a variable map generated by Winsteps

reliability index and item reliability index should be between 0 and 1 (Bond & Fox, 2007). The person ability measures were calculated for use in further analysis once the model fit and the variables were established.

4.5 Multivariate normality

Multivariate normality holds when the means of each dependent variable and their linear combination are normally distributed (Tabachnick & Fidell, 2013). A normal distribution represents the distribution of scores with largest frequencies at the centre and the smallest frequencies at the extreme ends producing a symmetrical, bell-shaped curve. The assumption of normality was essential to avoid Type 1 error. Type 1 error is rejecting the null hypothesis, when in reality it is true (Frick, 1996; Nickerson, 2000). A test of significance called multivariate analysis of variance (MANOVA) was based on multivariate normal distribution and was sensitive to outliers which produce Type 1 error.

Multivariate normality could be supported by the calculation of Mahalanobis distance (Pallant, 2013; Tabachnick & Fidell, 2013). The Mahalanobis distance indicates the distance of any one case from the centroid of the rest of the cases, where the centroid is the intersection point of the means of all the variables (Tabachnick & Fidell, 2013). Any case with an irregular score pattern will be picked up by this analysis. To check whether a case was an outlier or not, the Mahalanobis distance needed to be compared with the chi-square critical value table. If the maximum value for the overall Mahalanobis distance score (mah_1 score as in SPSS file) was greater than the critical value, then the case was regarded as an outlier (Pallant, 2013).

4.6 Multivariate analysis of variance

Multivariate analysis of variance (MANOVA) is used to compare groups when there was more than one dependent variable in the study (Tabachnick & Fidell, 2013). MANOVA provided information on whether the groups differed significantly on a linear combination of the dependent or outcome variables. In MANOVA, the emphasis is on the mean differences and the groups are compared on the basis of means on linear combination of the outcome variables. The variables in the present study, including attitude towards mathematics, mathematics anxiety and parental involvement were compared using MANOVA, the results of which are reported in the next chapter.

Multivariate statistics to test significant differences among groups on the composite dependent variable in MANOVA include Wilkis'Lambda, Pillai's Trace, Hotelling's trace, and Roy's greatest characteristic root (gcr) criterion. In situations where two groups are compared, the F test for Wilkis' Lambda, Pillai's Trace, and Hotelling's Trace are identical. A '*p*' value less than .05 for the selected statistic indicates significant differences among the groups. Effect size indicates the amount of variance in the dependent variable predicted by the independent variable (Pallant, 2013; Tabachnick & Fidell, 2013). The most common effect size statistics are partial eta squared and Cohen's *d*. Partial eta squared explains the proportion of variance in the dependent variable based on the independent variable and the value of partial eta squared ranges from 0 to 1 (Pallant, 2013; Tabachnick & Fidell, 2013). Cohen's *d* indicates the group mean differences in terms of standard deviation units (Tabachnick & Fidell, 2013). The present study reported partial eta squared as the effect size statistic as it was the commonly reported statistic generated by SPSS program.

4.7 Structural equation modeling

Structural equation modeling (SEM) employs a confirmatory approach to data analysis rather than an exploratory one. Thus it helps in the analysis of complex and multidimensional relationships simultaneously and completely (Ullman, 2013). Secondly, SEM helps in examining the relationships between variables free of measurement errors. The SEM analysis indicates only the common variance, as the errors had been estimated and removed (Byrne, 2010). Thirdly, SEM procedures help in integrating both observed and latent variables in the data analysis as opposed to other methods which used only observed variables (Byrne, 2010). Finally, SEM approaches help in testing multivariate relationships (Byrne, 2010). The present study adopted SEM procedures for these reasons.

The important steps involved in structural equation modeling are model specification, identification and estimation, and model modification. The SEM computer software AMOS 20.0.1 (Analysis of Moment Structures) (Arbuckle, 2012) was used in this study. The steps involved in SEM are discussed in the following sections.

4.7.1 Model specification

The first step in SEM involves model specification which means the development of models predicting relationships among variables and the indicators that best measure the latent variables. First, the measurement model showing relationships of the indicator variables to the unobserved variables have to be specified (Bollen, 1989). Once the measurement model has been specified, the next step is to specify the structural model by adding variables and more parameters.

4.7.2 Model identification

Model identification involves the process of checking whether a unique solution for the unknown parameters in the model can be estimated. A model is considered as just identified if the number of unknown parameters and the data points (i.e., variances and covariance of the observed variables) are equal (Ullman, 2006). An under-identified model is one having more unknown parameters than the data points (Byrne, 2010). Finally, an over identified model has more data points than the number of parameters (Byrne, 2010).

4.7.3 Model estimation and evaluation

The next step after the model specification and identification involves estimating the unknown parameters in the model and evaluating the model fit. The most commonly used estimation method for SEM is Maximum Likelihood (ML) estimation. A variety of fit measures generated by AMOS output are used to assess the fit of the model to the data. The most commonly used fit indices are chi-square (χ^2), Comparative fit index (CFI), Goodness-of-fit index (GFI), incremental fit index (IFI), and root mean squared error of approximation (RMSEA) as recommended by Byrne (2001) and Hu and Bentler (1999).

In SEM, the difference between the sample covariance matrix S and the implied covariance matrix $\Sigma(\theta)$ is expressed as the chi-square (χ^2) statistic (Byrne, 2010). All other things being equal, the chi-square statistic is sensitive to sample size. Thus the chi-square ratio (χ^2/df) value (df means degrees of freedom) is also taken into account to assess the model fit (Bollen, 1989), as the ratio is less influenced by size of the sample. The chi-square ratio values less than 2.00 are considered as acceptable for good fit (Bollen, 1989; Hu & Bentler, 1999; Ullman, 2006).

The measure of comparison between the independent model and the empirical model is represented by Normed fit index (NFI) in SEM. With smaller samples, NFI is found to underestimate the fit of the model (Byrne, 2010). A revised fit index called Comparative Fit Index (CFI) which takes into account the sample size can be used (Byrne, 2001, 2010). A CFI value of 0.95 or above is considered as acceptable for well fitting model (Byrne, 2010). The Incremental Index of Fit (IFI) provides an improved measure of fit over NFI taking into consideration the issue of sample size and parsimony (Byrne, 2010). The IFI value of 0.95 and above is considered acceptable for a good fitting model.

The Goodness-of-Fit Index (GFI) measures the quantity of sample variance and covariance as explained by the population covariance matrix (Byrne, 2010). GFI is considered as an absolute index of fit as the hypothesized model is not compared with any other model (Byrne, 2010). GFI values range from 0 to 1 and values close to 1.00 indicate a good fitting model (Byrne, 2010).

The Root Mean Square Error of Approximation (RMSEA) estimates the lack of fit of a model in comparison with the perfect or saturated model (Ullman, 2013). RMSEA values of 0.06 or less suggest a good fitting model (Hu & Bentler, 1995). Values of RMSEA from 0.08 to 0.10 indicate a moderate fitting model and values greater than 0.01 suggest a poor fitting model (Browne & Cudek, 1993; MacCallum, Browne, & Sugawara, 1996).

4.7.4 Model modification

This step involves modification of the models to correct the poor fit. AMOS provides a number of indices which suggest the ways the model could be improved. These include setting or freeing parameters, which can be done with strong theoretical grounds.

4.8 Multi-group analysis

In estimating the structural equation model, there are two different approaches as recommended by Anderson and Gerbing (1988); evaluation of the measurement model and the evaluation of the structural model separately. Testing the measurement model for equivalence includes assessing factorial invariance across groups (Vandenberg & Lance, 2000). Measurement invariance tests are essential in comparing groups (Byrne &

Watkins, 2003; Widaman & Reise, 1997) and the tests evaluate whether the same factors are being measured across the groups. Multi-group confirmatory factor analysis (MGCFA) was used to test measurement invariance. In MGCFA, a number of nested models are tested, adding increasingly stricter constraints, reflecting more and tighter levels of cross-group invariance (Crockett, Veed, & Russell, 2010).

The first in the series of tests for measurement invariance is configural invariance. Configural invariance is used to examine whether the factor structure is same for both males and females (Bollen, 1989; G. W. Cheung & Rensvold, 2002). Once configural invariance is established, the next one is metric (weak) invariance. In metric invariance testing it is determined whether the items have the same relative contribution to the measure across the groups (Crockett et al., 2010). After achieving metric invariance the model is tested for scalar invariance, with equality of factor loadings and intercepts across the groups. The invariance of error variance is tested next with factor loadings, item intercepts and error variances constrained to equal for both boys and girls. It should be noted that the test of invariance of error variance is not considered as an essential requirement for comparing groups (Byrne, 2001).

Once the metric and scalar invariance had been established, it was necessary to examine whether the latent means across the groups are invariant. As direct estimation of latent means is not possible, latent means differences across the gender groups are tested by keeping the male group as the reference group with a latent mean of zero (Hancock, 1997). Partial invariance is also possible in each step, when some of the components are not invariant across the groups (Byrne, Shavelson, & Muthen, 1989; Vandenberg & Lance, 2000).

The hypothesised measurement model for the study is shown in Figure 4.3. The latent variable mathematics anxiety was constructed from three indicators: students' report of their anxiety (sanxiety), their confidence in learning mathematics (sconfidence), and their effectance motivation (smotivation). The second latent variable, attitude towards mathematics, was constructed from four indicators namely, students' report of their general attitude towards maths and success in mathematics (sattitude), students' report of the usefulness of mathematics (susefulness), students' report of their parents' attitude towards maths and child's maths study (sparentattitude), and parents' report of their own attitude towards maths and child's maths study (pattitude). The third latent variable parental involvement was built from four indicators, students' report of their parents' behaviours in relation to child's maths learning (sparentbeh), parents' report of their own behaviours in relation to child's maths learning (pparentbeh), their mathematics anxiety (panxiety), and their expectations of their child's mathematics learning and future education (pexpectation). The achievement test score for this study was represented in the model as achievement measure.

Common method variance (CMV) indicates the variance arising from using the same method to measure two or more constructs in a single study. To minimise the effects of CMV, researchers generally use two remedial approaches - procedural or statistical. The procedural approach involves collecting ratings from multiple informants and the statistical approach involves controlling for a method factor (Podsakoff, MacKenzie, Lee, & Podsakoff, 2013). The first reason to include the student measures and parent measures was to minimise the bias due to common method variance (Podsakoff et al., 2013). Secondly, the student and parent measures were considered together in this study's model to improve the stability of the model (Fox, 1980; Bentler & Freeman, 1983). The stability index should be between -1 and 1 for a model to stable (Ullman, 1996). The model shown in Figure 4.3 has a stability index within the acceptable range.

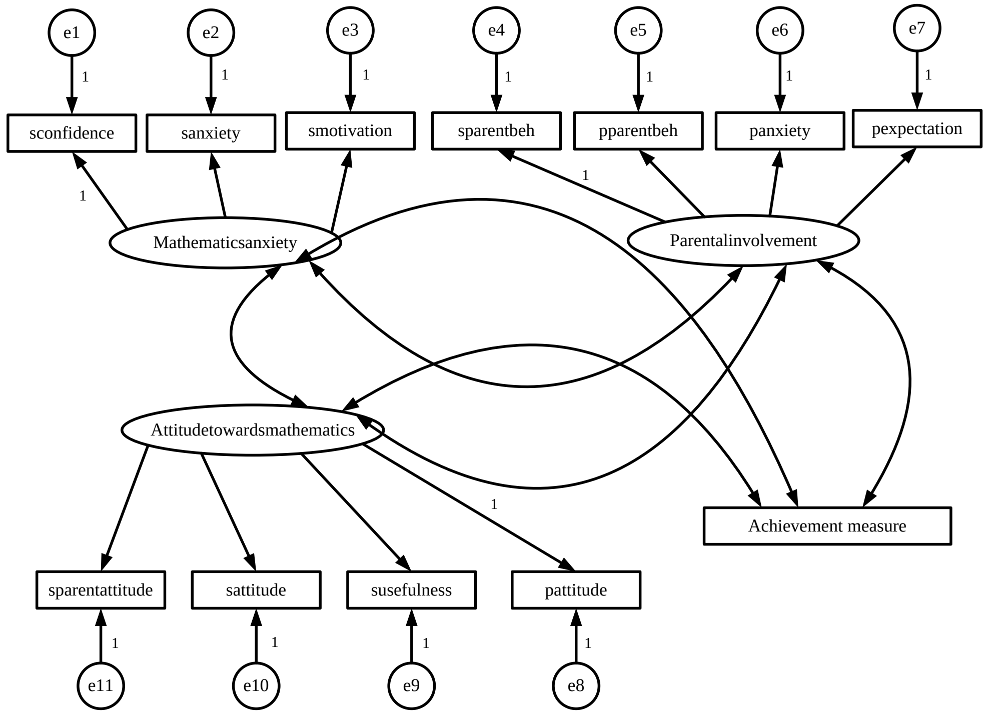


Figure 4.3. The hypothesised measurement model showing the relationship between the observed variables and the latent variables

The next step after establishing an acceptable measurement model was to evaluate the structural model. This involved examining whether the hypothesised structural paths were invariant across the two groups using multi-group structural equation modeling (MGSEM). The baseline model in which all the structural paths are freely estimated had to be compared with the full structural model with the structural paths constrained to be equal across the groups. Nested models give the provision of evaluating the change in model fit for each subsequent constraint. The model can be said to be invariant with respect to the added constraints, if there is not much decrease in the model fit values (De Geiter, Hofmans, De Cooman, & Pepermans, 2009).

As explained earlier in section 4.7.3, the goodness of fit of a model is assessed by the chi-square (χ^2) statistic (Bollen, 1989). However the chi-square statistic is sensitive to large sample sizes (Byrne, 2001; R. B. Kline, 1998). Thus the chi-square ratio or relative chi-square (χ^2/df) could be used to assess the model fit (Byrne, 2001). In general, a value of 2 or less for the chi-square ratio statistic considered a good fit (Ullman, 2006). The other fit indices that have been considered good indicators of fit are the comparative fit index (CFI) and the root mean square error approximation (RMSEA) (Hu & Bentler, 1995; R. B. Kline, 1998). A value of 0.95 or more for CFI (Hu & Bentler, 1999) and a value of 0.08 or less for RMSEA are considered as good fit for the model (Browne & Cudek, 1993).

The structural model depicting the relationship between the latent variables is shown in Figure 4.4.

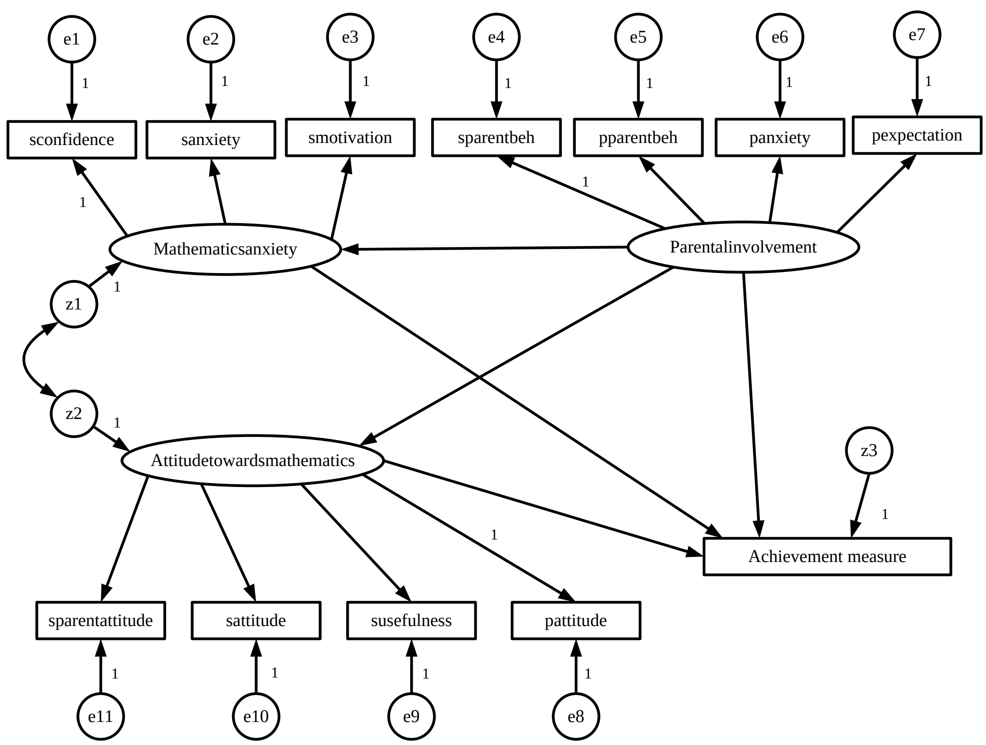


Figure 4.4. The structural model showing the relationship between the latent variables in the study

In the case of nested models, the measure used to evaluate the difference in fit between the models is the difference in χ^2 ($\Delta\chi^2$) between the models with difference in degrees of freedom (Δdf) (Hoyle, 1995). A statistically significant value of $\Delta\chi^2$ means that there is significant difference in the compared models (Mattern & Schau, 2002). Taking into consideration the sensitivity of $\Delta\chi^2$ to non-normally distributed data (Bollen, 1989; G. W. Cheung & Rensvold, 2002), another measure that has been considered for evaluating the fit of nested models is difference in CFI (ΔCFI) (G. W. Cheung & Rensvold, 2002). A non-significant change in CFI (ΔCFI) with a value of less than 0.01 can used for testing the invariance (G. W. Cheung & Rensvold, 2002).

4.9 Analysis of qualitative data

The main aim of the qualitative data was to complement the quantitative findings of this study. The interview data from students and parents in this study were transcribed as text files and then imported to NVivo version 10.0 (QSR International, 2012). Data from the interviews conducted in Malayalam were transcribed in Malayalam and then translated to English. The interview transcripts were not reviewed by the participants because the researcher was in Australia and contact details (email or postal address) were not provided by the participants. The full interview transcripts of students and parents were provided in Appendix K. The coded interview data were not included in the thesis.

Thematic analysis is usually used for analysing qualitative data; especially interview data. A theme means a key idea emerging from the data (Willis, 2010). In certain cases, themes emerge from the literature review and analysis involves exploring these themes amongst the collected data (Fereday & Muir-Cochrane, 2006). In other cases, themes emerge from repeated reading and coding of the interview data (Fisk & Neville, 2011;

Patton, 1980). In this study the interview responses were first coded, by the researcher, based on pre-determined themes based on the literature. The pre-determined themes were maths attitude, usefulness of maths, maths anxiety, self-confidence, helps in maths work, home work, parent behaviours, parent expectation, parent supervision, and decision making. A second round of examination of the data resulted in coding based on emerging themes from the data itself. The themes that emerged were future ambition, teacher, and maths course. The interviews were conducted in Malayalam, the mother tongue of the participants. So it was not feasible to use a second coder to check the reliability. Extensive discussions were conducted with senior researchers in the faculty before and after the coding of the interview data.

The next step in the qualitative analysis was the comparison among cases in the study. Case comparisons enable the researcher to explore similarities and differences in the phenomena under study demonstrated by the cases (Gibbs, 2002). To compare cases, first the concepts related to the codes were identified. Secondly, the common themes among the persons were compared (Miles & Huberman, 1994).

This section discussed the approaches employed for the analysis of interview data in the study. The chapter as a whole explained the data analysis approaches adopted for the quantitative and qualitative data in the study. The next chapter, Chapter 5, presents the results of the study.

CHAPTER 5 RESULTS OF THE STUDY

5.1 Introduction

This chapter describes the results of the study in terms of the descriptive statistics, Rasch analysis results, results of an analysis of multivariate normality, multivariate analysis of variance results, structural equation modeling results, and results from the qualitative data analysis. The first section includes the details of the participating students and parents. The next section includes the results of Rasch modelling, followed by results of multivariate normality analysis and multivariate analysis of variance. The remaining two sections deal with the structural equation modeling results and the qualitative analysis results respectively.

5.2 Descriptive statistics

This section details the sample of the study, Year 9 and Year 11 students and their parents, from a co-educational Catholic school in Kerala, India.

5.2.1 Student participants

As described in Chapter 3, a sealed envelope containing the parent consent forms for student questionnaire and achievement test, student information sheet for the questionnaire and the achievement test, and the parent questionnaire was sent home through all the students in Year 9 and Year 11. After a week, the signed parental consent forms for the child and the completed parent questionnaire in the sealed envelopes addressed to the researcher were collected by the respective class teachers. Of the 135 students who completed the questionnaire and the achievement test in their respective classes, data from 107 students (79.3%) were used for further analysis in the study because a parent also completed a questionnaire. Of the 107 students, 44 (41.1%) were male and 63 (58.9%) were female. There were 63 (58.9%) students from Year 9 and 44 (41.1%) students from Year 11. The average age of the students was 14.89 years (*SD*=1.03). Also the average age of Year 9 students was 14.08 years (*SD*=0.28) and that of Year 11 students was 16 years (*SD*=0.48).

5.2.2 Parent participants

Parent questionnaires were sent home in a sealed envelope with all the students in Year 9 and Year 11. Parents were asked to return the completed questionnaire within a week to the respective class teachers. From the 118 parents who completed the questionnaire, data from a total of 107 (90.7%) parents were used for further analysis in the study, after matching with the student data. Of the 107 parents, 51 (47.7%) were fathers and 54 (50.5%) were mothers. The remaining two were a grandmother and a foster parent.

5.3 Results of Rasch analysis

This section describes the results obtained from fitting the data from the student questionnaire and parent questionnaire to the Partial Credit Model (PCM). Winsteps version 3.75.1 (Linacre, 2012) was used to generate the results.

5.3.1 Student questionnaire data

The student questionnaire comprised eight subscales and the students were asked to rate their agreement with each of the statements in the subscales on a 5-point Likert scale with the choices Strongly Disagree, Disagree, Undecided, Agree, and Strongly Agree. The two subscales attitude towards maths and success in mathematics (***sattitude***) scale and usefulness mathematics (***susefulness***) scale measured the construct attitude towards mathematics. The construct mathematics anxiety was measured using the subscales, anxiety (***sanxiety***), confidence in learning mathematics (***sconfidence***), and effectance motivation (***smotivation***) scale. Lastly, the three subscales, parent behaviours (***sparentbeh***), parent attitudes (***sparentattitude***), and parenting style (***sparsty***) were used to measure the students'perceptions of their parents' involvement in their mathematics learning.

The reliability of the subscales used in this study was assessed by Cronbach alpha reliability coefficient. A Cronbach alpha coefficient of 0.70 or greater was considered as acceptable (Byrne, 2001; P. Kline, 1993; Pallant, 2013). In the present study, the student questionnaire had a Cronbach alpha reliability coefficient of 0.92 for the whole scale and the individual subscales had Cronbach alpha coefficients ranging from 0.60 to 0.83, excluding parenting style (sparsty) scale. The parenting style (sparsty) scale with 15 items had a Cronbach alpha coefficient of 0.48 and was not found to influence any of the other factors and therefore, removed from the analysis. Data from the remaining subscales were subjected to Rasch analysis and the overall fit statistics were obtained. A student with infit and outfit mean square of 5.99 and infit t value of 8.6 and an outfit t value of 8.4 was found. These values were out of the acceptable range of mean square value and the acceptable value of zero for the t statistics. Thus this student's data from all the instruments were removed, leaving a total of 106 cases for further analysis.

The student data from the ***sattitude*** scale comprising 10 items, measuring students' general attitude towards maths and success in mathematics were analysed using Rasch modelling to establish the data fit. Of the ten items in the ***sattitude*** scale, two items (sattitude 2 - I do as little maths as possible when I get the choice and sattitude 10 - I don't like people to think I'm smart in maths) had infit values greater than 2. So these two items were removed from further analysis (Bond & Fox, 2007). The remaining items showed a good fit to the model with a value of 1.01 for the infit mean square and a value of 1.00 for the outfit mean square for the scale. These values were close to the expected Rasch modelled value of 1. The infit and outfit t values were also close to the expected value of zero. The item separation reliability index of 0.95 was within the acceptable range (Bond & Fox, 2007). The item estimate mean (default) was 0.00 with SD=0.53. The fit measures are shown in Table 5.1.

Table 5.1

Summary of the overall fit statistics for the sattitude scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.53)		0.80 (0.71)	
Separation Index	0.95		0.57	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.01	0.00	1.00	-0.10
SD	0.18	1.20	0.14	0.80
Person				
Mean	0.96	-0.10	1.00	0.00
SD	0.62	1.20	0.67	1.10

The person fit measures also indicated a good fit to the model with infit and outfit mean square values of 0.96 and 1.00, close to the expected value of 1.00 in Rasch modelling. The infit t value of -0.10 and the outfit t value of 0.00 were close to the expected value of zero. The calculated person separation reliability index of 0.57 was low compared to the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.67. The person estimate mean of 0.80 (*SD*=0.71) showed that the sample of students found the items relatively easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The variable map showing the distribution of items and persons in the ***sattitude*** scale is given in Figure 5.1.

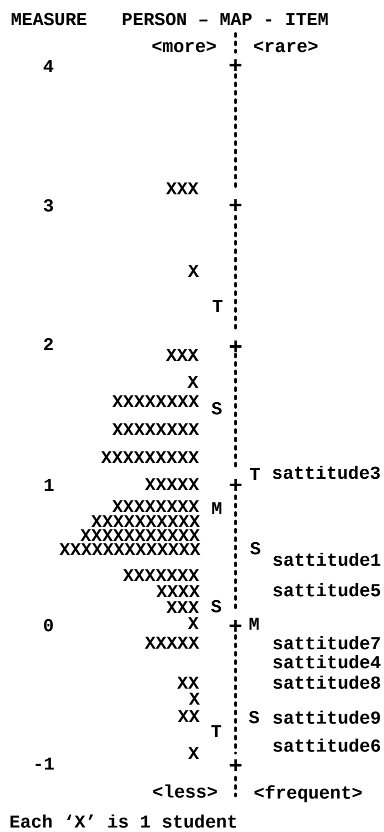


Figure 5.1. Variable map showing the distribution of items and persons for sattitude scale

The items were represented on the right hand side based on their difficulty level. The difficult items were placed on top of the scale and the easiest items at the bottom of the scale. The students were represented on the left hand side by x. For further analysis the person ability measures were calculated.

The 8-item sattitude scale showed good fit to the Rasch model, and the item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.67. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items relatively easy to endorse, as shown by the discrepancy between the item and person means. Of the items 'Maths is the easiest subject at school'(sattitude 3) was the most difficult for the students to support, located towards the top of the scale.

The data from the **susefulness** scale with 10 items, measuring students' perception of the usefulness of mathematics were analysed to measure the fit. The overall fit statistics showed acceptable fit as the fit measures were satisfactory. The item infit (1.03) and outfit (1.01) mean square values showed an acceptable fit as the values were close to 1. The t values also indicated satisfactory fit with values 0.20 and 0.10. In addition, the item estimate mean was 0.00 by default with a SD of 0.40. The separation reliability index for item was 0.92 which was in the acceptable range (Bond & Fox, 2007). Table 5.2 shows the overall fit statistics for the susefulness scale.

Table 5.2

Summary of the overall fit statistics for the susefulness scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.40)		0.80 (0.93)	
Separation Index	0.92		0.75	
	Fit Statistics			
	Infit		Outfit	
	Mean square	t	Mean square	t
Item				
Mean	1.03	0.20	1.01	0.10
SD	0.16	1.10	0.16	1.00
Person				
Mean	1.03	-0.10	1.01	-0.10
SD	0.63	1.50	0.63	1.40

The mean square values obtained for persons were similar to the item mean square values and were close to the Rasch modelled value of 1. The infit and outfit t values of -0.10 were also satisfactory. These person fit measures indicated acceptable fit of the data to the model. The person estimate mean was 0.80 (*SD*=0.93), indicating that the items of the scale were relatively easy for the sample of students to endorse (Bond & Fox, 2007; Phillipson, 2008). The person separation reliability index of 0.75 was in the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.81. Figure 5.2 represents the variable map showing the distribution of items and persons. The person ability measures were calculated for further analysis.

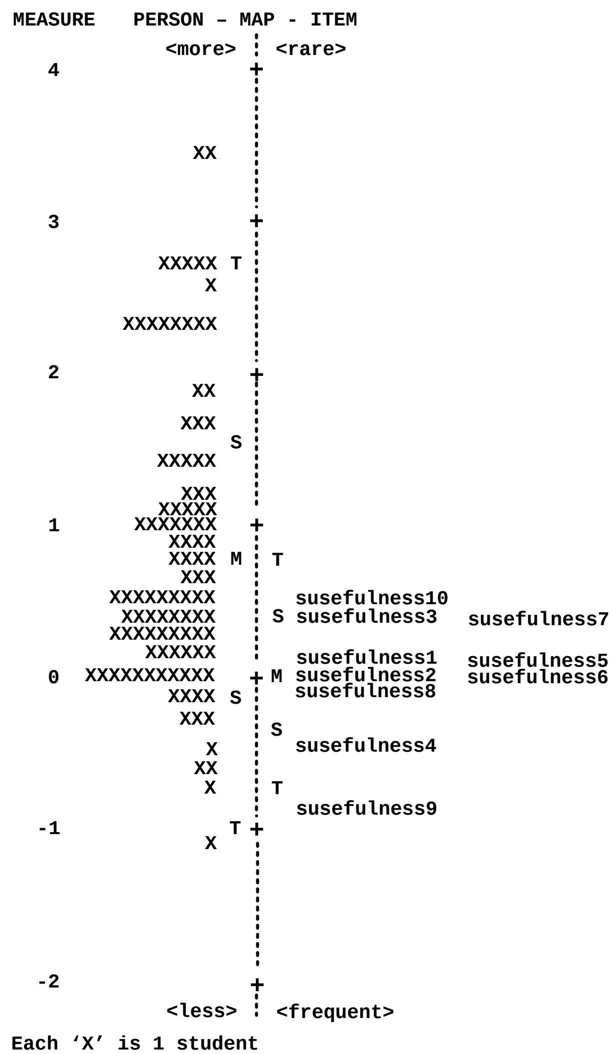


Figure 5.2. Variable map showing the distribution of items and persons for susefulness scale

The 10-item susefulness scale showed good fit to the Rasch model, and the item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.81. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items relatively easy to endorse, as shown by the discrepancy between the item and person means. The item ‘I expect to have little use for mathematics when I get out of school’(susefulness 10) was the most difficult for the students to endorse.

The ***sconfidence*** scale with 10 items measured students’ confidence in learning mathematics and the data were analysed to measure the fit of the data to the model. Satisfactory overall fit statistics suggested good fit of the data to the model. The item infit and outfit fit mean square values obtained were 1.02 and 1.00 respectively, close to the expected value of 1. The infit t value of 0.10 and the outfit t value of 0.00 were also acceptable as these values were close to zero. The item estimate mean by default was 0.00 with a *SD* of 0.46. The item separation reliability index of 0.94 was within the acceptable range (Bond & Fox, 2007). The summary of the overall fit statistics is given in Table 5.3.

Table 5.3

Summary of the overall fit statistics for the sconfidence scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.46)		0.46 (0.91)	
Separation Index	0.94		0.79	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.02	0.10	1.00	0.00
SD	0.18	1.30	0.19	1.30
Person				
Mean	0.99	-0.20	1.00	-0.10
SD	0.69	1.50	0.71	1.40

The person infit and outfit mean square values of 0.99 and 1.00 were near to the Rasch modelled expected value of 1. Also, the infit and outfit t values for person (-0.20 & -0.10) were close to the expected value of zero suggested by Rasch modelling. The person estimate mean of 0.49 (SD=0.91) indicate that the sample of students found the items comparatively easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The value of 0.79 for the person separation index was also within the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.84. The variable map in Figure 5.3 represents the distribution of items on the right hand and the persons on the left hand side. For further analysis, the person ability measures were calculated.

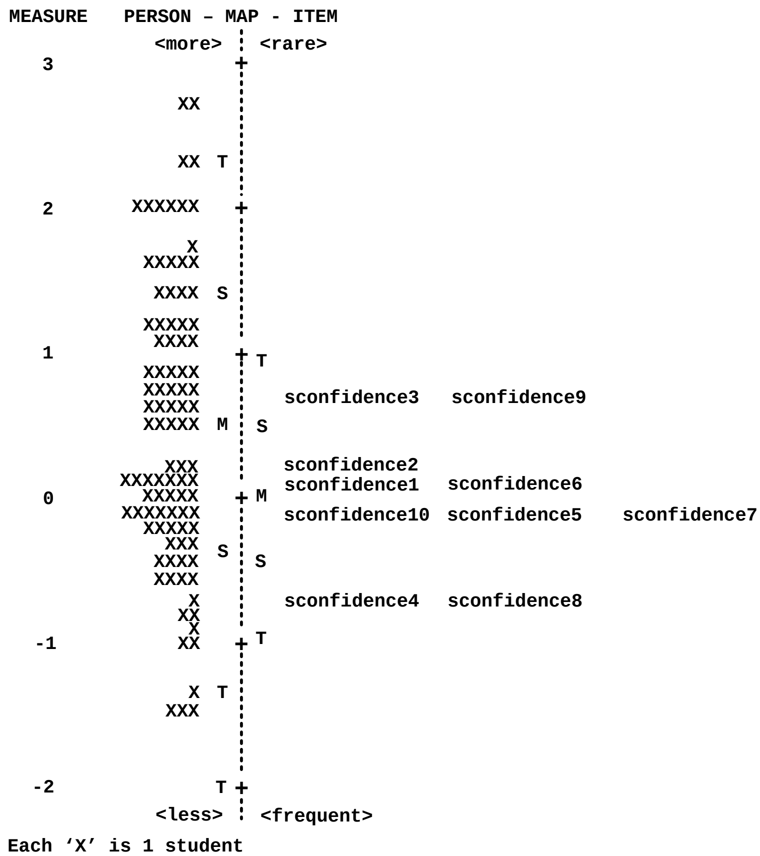


Figure 5.3. Variable map showing the distribution of items and persons for sconfidence scale

The 10-item sconfidence scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.84. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items comparatively easy to support, as shown by the discrepancy between the item and person means. The items 'I think I can handle difficult mathematics'(sconfidence 3) and 'For some reason even though I study hard, mathematics is difficult for me'(sconfidence 9) were more difficult for the students to endorse.

The student data from the ***sanxiety*** scale with 10 items, measuring students' anxiety in mathematics was analysed using Rasch modeling to establish the data fit. The item sanxiety 5 had an infit value of 2.78 and was removed from further analysis (Bond & Fox, 2007). The overall fit statistics for the sanxiety scale with 9 items measuring students' anxiety in maths were satisfactory indicating a good fit of the data to the model. The item infit and outfit mean square values of 1.02 were near to the Rasch modelled expected value of 1.00. The infit and outfit t value of 0.10 for item was also close to the expected value of zero in Rasch modelling suggesting a good fit of the data to the model. The item mean estimate was 0.00 (default) with a *SD* of 0.32. The item separation reliability index of 0.88 was within the acceptable range (Bond & Fox, 2007). The summary of the overall fit statistics is given in Table 5.4.

Table 5.4

Summary of the overall fit statistics for the sanxiety scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.32)		0.30 (0.94)	
Separation Index	0.88		0.79	
	Fit Statistics			
	Infit		Outfit	
	Mean square	t	Mean square	t
Item				
Mean	1.02	0.10	1.02	0.10
SD	0.15	1.20	0.17	1.20
Person				
Mean	1.01	-0.20	1.01	-0.10
SD	0.71	1.50	0.71	1.50

The infit and outfit mean square values of 1.02 for person were in the expected range of Rasch modelled value of 1.00. The infit and outfit t values were also close to the expected value of zero. The calculated person separation reliability index of 0.79 was in the expected range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.85. The person estimate mean with a value of 0.30 suggested that the sample of students in the study found most of the items relatively easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The variable map in Figure 5.4 represents the distribution of items and students along the scale. The students are represented on the left hand side by x and the items on the right hand side, based on their level of difficulty. The difficult items are placed towards the top of the scale and the easy items at the bottom of the scale. The person ability measures were calculated for further analysis.

```
MEASURE   PERSON – MAP - ITEM
              <more> | <rare>
 3                X  +
                     |
                     |
                     |
                     |
                  X T|
 2              XXX  +
             XXXXXX  |
                     |
                XXX  |
               XXXX S|
             XXXXXX  |
 1                X  +
                XXX  |
              XXXXX  | T
             XXXXXX S|
         XXXXXXXXXX  |   sanxiety2  sanxiety9
            XXXXXXX  | S
               XXXX M|
            XXXXXXX  |   sanxiety10
 0             XXXX  + M sanxiety1  sanxiety4
             XXXXXX  |   sanxiety3
             XXXXXX  |   sanxiety7
                XXX  |
                 XX  | S sanxiety6  sanxiety8
                 XX S|
               XXXX  | T
                 XX  |
-1               XX  +
                 XX  |
                 XX  |
                  X T|
                  X  |
-2                   +
                 XX  |
                     |
                     |
                     |
-3                   +
              <less> | <frequent>
Each ‘X’ is 1 student
```

Figure 5.4. Variable map showing the distribution of items and persons for sanxiety scale

The 9-item sanxiety scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.85. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items relatively easy to endorse, as shown by the discrepancy between the item and person means. The items 'I never get nervous during a maths test'(sanxiety 2) and 'I worry about my ability to solve maths problems'(sanxiety 9) were more difficult for the students to endorse.

The ***smotivation*** scale's fit statistics were satisfactory suggesting a good fit of the data to the model. The scale had 10 items and measured students' motivation in learning mathematics. The item mean square values and the t values were within the acceptable range of the Rasch modelled value for mean square and t values. The infit and outfit mean square values of item were 1.00 and 1.03 and the infit and outfit t values were zero and 0.20. The item estimate mean by default was zero with *SD* of 0.28. The item separation reliability index obtained was within the acceptable range with a value of 0.88 (Bond & Fox, 2007). The summary of the fit statistics is given in Table 5.5.

Table 5.5

Summary of the overall fit statistics for the smotivation scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.28)		0.41 (0.73)	
Separation Index	0.88		0.70	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.00	0.00	1.03	0.30
SD	0.08	0.60	0.11	0.80
Person				
Mean	1.03	-0.10	1.03	-0.10
SD	0.59	1.40	0.56	1.30

The person fit measures were also in the acceptable range with an infit mean square value of 1.00 and outfit mean square value of 1.03. The infit and outfit t values were also close to the acceptable value of 1. The person estimate mean was 0.41 with *SD* 0.73. This indicates that items were relatively easy for the sample of students to endorse (Bond & Fox, 2007; Phillipson, 2008). The person separation index of 0.70 was also within the acceptable value for the index (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.72. For further analysis, the person ability measures were calculated. The distribution of items and persons on the measurement logit scale is shown in Figure 5.5.

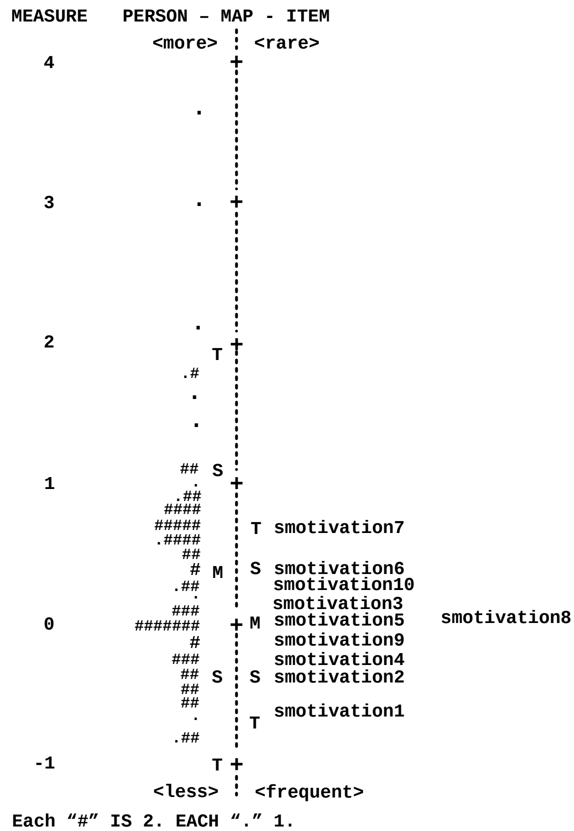


Figure 5.5. Variable map showing the distribution of items and persons for smotivation scale

The 10-item smotivation scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.72. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items relatively easy to endorse, as shown by the discrepancy between the item and person means. The item ‘I don’t understand how some people can spend so much time on maths and seem to enjoy it’(smotivation 7) was the most difficult for the students to agree or disagree with.

The data from the ***sparentbeh*** scale with 10 items were analysed using Rasch modelling to establish the fit of the data to the model. The scale measured students' perception of their parents' behaviours in relation to their maths learning. The item infit and outfit mean square values obtained were 1.00 and 1.01 respectively. The above values were close to the expected value of 1 in Rasch modelling. Rasch modelling requires an ideal value of zero for infit and outfit t values. Against this, the value obtained was 0.10 for both infit and outfit measure, which was close to the expected value of zero. These values indicate a good fit of the data to the model (Bond & Fox, 2007). The item estimate mean was 0.00 (default) with *SD* of 0.75. The item separation reliability index of 0.98 was also within the acceptable range (Bond & Fox, 2007). The fit statistics summary is shown in Table 5.6.

Table 5.6

Summary of the overall fit statistics for the sparentbeh scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.75)		0.66 (0.62)	
Separation Index	0.98		0.58	
	Fit Statistics			
	Infit		Outfit	
	Mean square	t	Mean square	t
Item				
Mean	1.00	0.10	1.01	0.10
SD	0.17	1.20	0.20	1.30
Person				
Mean	1.05	0.00	1.01	0.00
SD	0.67	1.30	0.61	1.10

The person fit statistics calculated for the ***sparentbeh*** scale indicated a good fit to the model with a value of 1.05 for infit mean square and 1.01 for outfit mean square. The t value was zero for both infit and outfit measures. The person estimate mean was 0.66, indicating that the students found the items comparatively easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The calculated person separation reliability index of 0.58 was low compared to the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.71. Figure 5.6 represents the items and persons distribution on the logit scale. The items are represented on the right hand side of the scale with difficult items at the top and the easiest items at the bottom. The persons were represented on the left hand side by x. The person ability measures were obtained for further analysis.

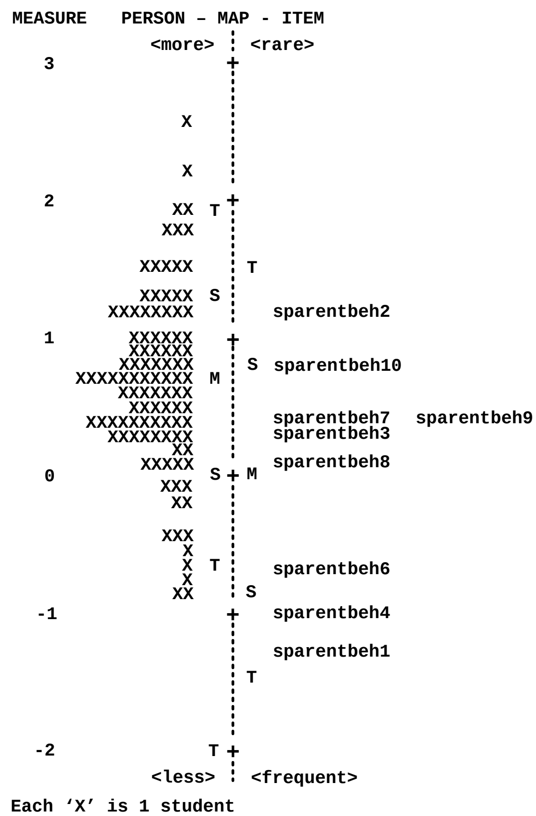


Figure 5.6. Variable map showing the distribution of items and persons for sparentbeh scale

The 10-item sparentbeh scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.71. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items comparatively easy to endorse, as shown by the discrepancy between the item and person means. The item 'My parents check my maths homework regularly'(sparentbeh 2) was the most difficult for the students to endorse.

The ***sparentattitude*** scale with 10 items measured students' perception of their parents' attitude towards maths and their child's maths study. The overall fit statistics obtained for the sparentattitude scale indicated that the data fitted the Rasch model well. This was evident from the mean square and *t* values obtained for the items. The item infit mean square value of 1.06 and the item outfit mean square value of 1.02 were close to the expected value of 1.00 in Rasch modelling. The infit and outfit *t* values were in the acceptable range. The item mean estimate was zero (default) with a *SD* of 0.39. The item separation reliability index of 0.90 was in the acceptable range (Bond & Fox, 2007). The overall fit statistics for the scale is shown in Table 5.7.

Table 5.7

Summary of the overall fit statistics for the sparentattitude scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.39)		1.12 (0.79)	
Separation Index	0.90		0.61	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.06	0.30	1.02	0.10
SD	0.20	1.10	0.14	0.90
Person				
Mean	1.03	0.00	1.02	0.00
SD	0.67	1.30	0.71	1.30

The person fit measures were also indicated good fit of the data with mean square values (1.03 & 1.02) near to the expected value of 1.00 in Rasch modelling. The infit and outfit t values were equal to zero. The person estimate mean was 1.12, suggesting that the student sample found the items easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The calculated person separation reliability index of 0.61 was low compared to the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.72. The variable map in Figure 5.7 represents the distribution of persons and items on the measurement scale. The items are shown on the right hand side and the persons on the left hand side represented by #. For further analysis the person ability measures were calculated.

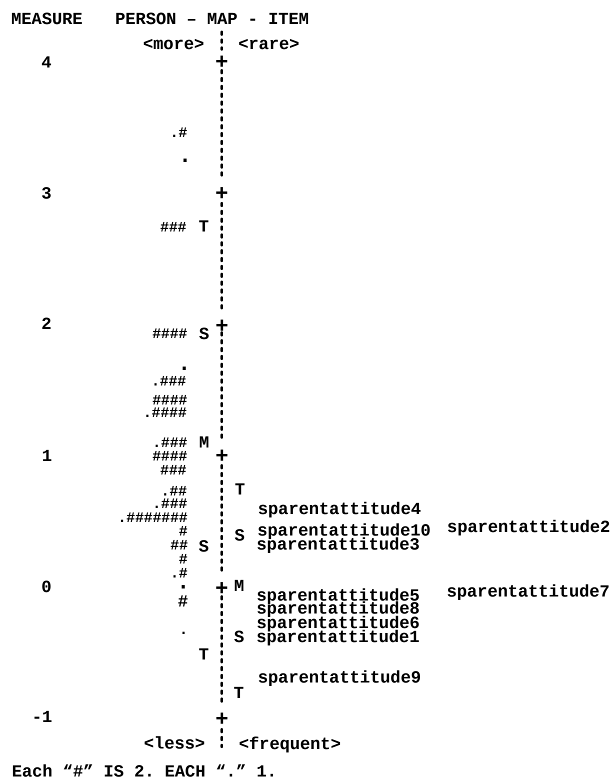


Figure 5.7. Variable map showing the distribution of items and persons for sparentattitude scale

The 10-item sparentattitude scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.72. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items comparatively easy to endorse, as shown by the discrepancy between the item and person means. The item ‘My parents think I am the kind of person who could do well in mathematics’(sparentattitude 4) was the most difficult for the students to agree or disagree with.

5.3.2 Parent questionnaire data

The parent questionnaire comprised five scales namely, parent behaviours (***pparentbeh***) scale, parent maths anxiety (***panxiety***) scale, parental expectations (***pexpectation***) scale, and parent attitude towards maths and child’s maths study (***pattitude***) scale and parenting style (***pparsty***) scale . The ***pparentbeh*** scale measured parents’ behaviours in relation to their child’s maths learning, ***panxiety*** scale measured parents’ anxiety in mathematics, the ***pexpectation*** scale measured parental expectations for his/her child’s mathematics learning and future education, the ***pattitude*** scale measured parents’ attitude towards maths and his/her child’s maths study and the ***pparsty*** scale measured parents’perceptions of their involvement in their child’s mathematics learning.

The Cronbach alpha coefficient for the whole scale was 0.89 and the individual scales had Cronbach alpha coefficients ranging from 0.52 to 0.86, with the exception of the ***pparsty*** scale. The ***pparsty*** scale with 12 items had a Cronbach alpha coefficient of 0.19 and was, therefore, removed from the analysis. The Cronbach alpha coefficient for the ***pexpectation*** scale with 4 items was 0.52. A total of 106 parents’ data were used for analysis after matching with the student data. The data from the scales, except the ***pparsty*** scale, were subjected to Rasch analysis to confirm data fit and the fit measures were calculated.

The ***pparentbeh*** scale with 10 items showed overall fit measures within the acceptable range, suggesting a good fit of the data to the model. The mean item estimate by default was zero with a *SD* of 1.04. The item infit mean square value of 1.04 and the outfit mean square value of 1.05 were in the acceptable range, close to the expected value of 1. Table 5.8 displays the summary of the fit measures for the pparentbeh scale.

Table 5.8

Summary of the overall fit statistics for the pparentbeh scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (1.04)		1.21 (0.97)	
Separation Index	0.98		0.72	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.04	0.10	1.05	0.20
SD	0.22	1.30	0.25	1.40
Person				
Mean	1.04	-0.10	1.05	0.00
SD	0.75	1.40	0.77	1.30

The infit and outfit *t* values were also close to the expected Rasch modelled value of zero. The item separation reliability index of 0.98 was near to the expected value of 1 (Bond & Fox, 2007). The person infit mean square value of 1.04 and the outfit mean square value of 1.05 was near to the Rasch modelled acceptable value of 1. The infit *t* value was -0.10, near to the acceptable value of zero and the outfit *t* value was zero. The person estimate mean was 1.21 indicating that the sample of parents found the items easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The person separation reliability index was also within the expected range with a value of 0.72 (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.79. The distribution of items and persons on the measurement scale is represented in Figure 5.8.

```
MEASURE   PERSON - MAP - ITEM
             <more> | <rare>
  4                 +
                    |
               X    |
                    |
                  T |
  3         XXXX    +
                    |
           XXXXX    |
                    |
       XXXXXXXXX    |
                  S |
  2      XXXXXXX    + T
         XXXXXXX    |
                    |
       XXXXXXXXX    |
        XXXXXXXX    |   pparentbeh2
             XXX    |
   XXXXXXXXXXXXX M  |   pparentbeh9
  1       XXXXXX    + S
       XXXXXXXXX    |   pparentbeh3
               X    |   pparentbeh7
          XXXXXX    |
             XXX    |
            XXXX S  |   pparentbeh4
             XXX    |
  0         XXXX    + M pparentbeh8
                    |
              XX    |
               X    |
              XX    |
               X T  |   pparentbeh5   pparentbeh6
              XX    |
 -1            X    + S
                    |
                    |   pparentbeh1
                    |
                    |
                    |   pparentbeh10
 -2                 + T
             <less> | <frequent>
Each 'X' is 1 student
```

Figure 5.8. Variable map showing the distribution of items and persons for pparentbeh scale

The items are represented on the right hand side of the scale based on difficulty level. The difficult items are displayed at the top of the scale and the easiest items at the bottom of the scale. The persons are represented on the left hand side by x. The person ability measures were calculated for further analysis.

The 10-item pparentbeh scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.79. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items relatively easy to endorse, as shown by the discrepancy between the item and person means. The item 'I regularly check my child's maths homework'(pparentbeh 2) was the most difficult for the parents to endorse.

The data from the ***panxiety*** scale with 9 items were analysed using Rasch modelling to establish the fit of the data to the model. The item infit and outfit mean square values obtained were 0.99 and 1.05 respectively. These values were close to the expected value of 1 in Rasch modelling. Rasch modelling requires an ideal value of zero for infit and outfit *t* values. Against this, the obtained *t* values were -0.20 and 0.20, close to the expected value of zero. These values indicate a good fit of the data to the model (Bond & Fox, 2007). The item estimate mean was 0.00 (default) with *SD* of 0.34. The item separation reliability index of 0.85 was also within the acceptable range (Bond & Fox, 2007). The fit statistics summary is shown in Table 5.9.

Table 5.9

Summary of the overall fit statistics for the panxiety scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.34)		0.65 (1.55)	
Separation Index	0.85		0.85	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	0.99	-0.20	1.05	0.20
SD	0.26	2.00	0.33	1.90
Person				
Mean	1.03	-0.20	1.05	-0.20
SD	0.92	1.50	1.02	1.50

The person fit statistics calculated for the panxiety scale indicated a good fit to the model with a value of 1.03 for infit mean square and 1.05 for outfit mean square. The t value was -0.20 for both infit and outfit measures. The person estimate mean was 0.65 indicating that the parents found the items comparatively easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The person separation reliability index of 0.85 was also within the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.86. Figure 5.9 represents the items and persons distribution on the logit scale. The person ability measures were obtained for further analysis.

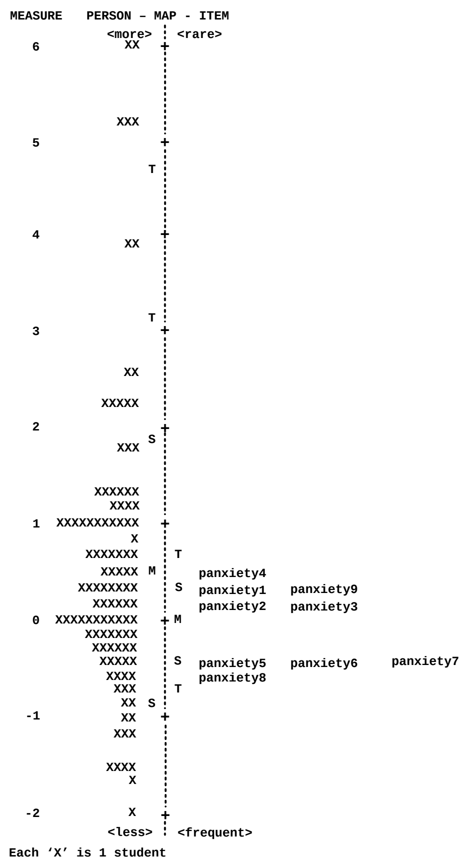


Figure 5.9. Variable map showing the distribution of items and persons for panxiety scale

The 9-item panxiety scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.86. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items comparatively easy to endorse, as shown by the discrepancy between the item and person means. The item 'As a student, I usually have been at ease during maths test'(panxiety 4) was the most difficult for the parents to endorse.

The data from the ***pexpectation*** scale with 4 items were analysed to establish the fit. The overall fit statistics showed acceptable fit as the fit measures were satisfactory. The item infit (1.04) and outfit (1.00) mean square values showed an acceptable fit as the values were close to 1. The *t* values also indicated satisfactory fit with values 0.20 and zero. In addition, the item estimate mean by default was 0.00 with a *SD* of 1.00. The separation reliability index for item was 0.97 which was in the acceptable range (Bond & Fox, 2007). Table 5.10 shows the overall fit statistics for the pexpectation scale.

Table 5.10

Summary of the overall fit statistics for the pexpectation scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (1.00)		2.21 (1.51)	
Separation Index	0.97		0.52	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.04	0.20	1.00	0.00
SD	0.15	0.90	0.13	0.80
Person				
Mean	0.98	-0.10	1.005	-0.10
SD	1.03	1.10	1.12	1.10

The mean square values (0.98 & 1.00) obtained for persons were also close to the

Rasch modelled value of 1. The infit and outfit *t* values of -0.10 were also satisfactory. These person fit measures indicated acceptable fit of the data to the model. The person estimate mean was 2.21, indicating that the items of the scale were easy for the sample of parents to endorse (Bond & Fox, 2007; Phillipson, 2008). The person separation reliability index of 0.52 was low compared to the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.52.

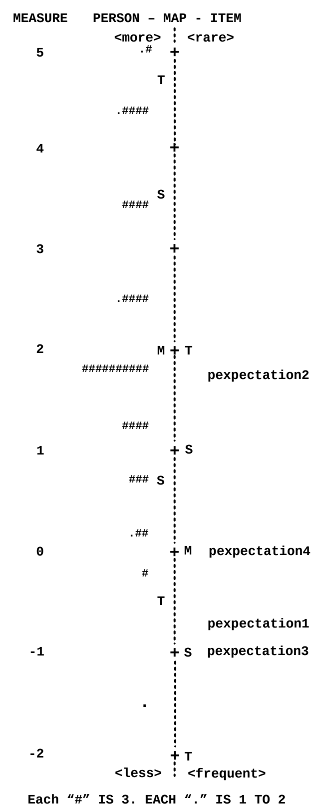


Figure 5.10. Variable map showing the distribution of items and persons for pexpectation scale

Figure 5.10 represents the variable map showing the distribution of items and persons. The items are represented on the right hand side of the scale with difficult items at the top and the easiest items at the bottom. The persons were represented on the left hand side by #. The ability measures for persons were calculated for further analysis.

The 4-item pexpectation scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.52. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items comparatively easy to endorse, as shown by the discrepancy between the item and person means. The item 'I think that my child will study advanced maths courses in university'(pexpectation 2) was the most difficult for parents to endorse.

The overall fit measures for the ***pattitude*** scale with 10 items were within the acceptable range suggesting a good fit of the data to the model. The infit and outfit mean square for the item were 1.02 and 1.08 respectively. These values were close to the Rasch modelled acceptable value of 1. The infit and outfit t values of 0.4 and 0.8 for the item were also close to the expected value of zero. The mean item estimate was 0.00 (default) with a *SD* of 0.63. The item separation reliability index of 0.94 was close to the expected value of 1 in Rasch modelling (Bond & Fox, 2007). The infit and outfit measures for person were also within the acceptable range. The person infit and outfit values of 1.07 and 1.08 were in the acceptable range. The infit and outfit t values for person were the exact value of zero. The person estimate mean was 1.79 indicating that the sample of parents found the items very easy to endorse (Bond & Fox, 2007; Phillipson, 2008). The separation reliability index for the person of 0.72 was also within the expected range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.80. The summary of the fit measures for the pattitude scale is shown in Table 5.11.

Table 5.11

Summary of the overall fit statistics for the pattitude scale

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.63)		1.79 (1.24)	
Separation Index	0.94		0.72	
	Fit Statistics			
	Infit		Outfit	
	Mean square	*t*	Mean square	*t*
Item				
Mean	1.02	0.20	1.08	0.40
SD	0.23	1.50	0.26	1.60
Person				
Mean	1.07	0.00	1.08	0.00
SD	0.82	1.40	0.86	1.40

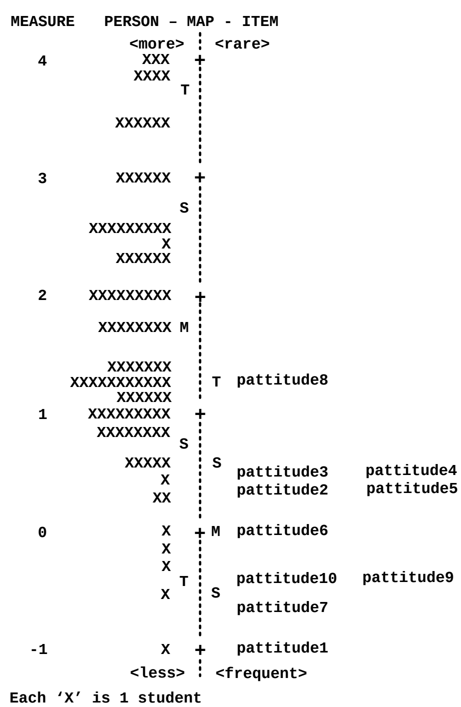


Figure 5.11. Variable map showing the distribution of items and persons for pattitude scale

The variable map in Figure 5.11 shows the distribution of items and persons along the measurement scale. Based on the difficulty of the items, they were represented on the right hand side. The persons were represented on the left hand side by x. The person ability measures were calculated for further analysis.

The 10-item pattitude scale in this study showed good fit to the Rasch model, and item and person separation reliabilities were acceptable. The Cronbach alpha reliability was 0.80. These findings indicate that the items were working together in consistent ways to provide a measurement scale that could be used to draw inferences about respondents. The students found the items comparatively easy to endorse, as shown by the discrepancy between the item and person means. The item ‘I am not concerned whether my child takes more maths courses in future’(pattitude 8) was the most difficult for the parents to endorse. The overall fit statistics for all the items in the student questionnaire and the parent questionnaire, from the Rasch analysis are provided in Appendix L and Appendix M respectively.

5.3.3 Achievement test data

The data obtained from the student achievement test were analysed using Rasch modelling. The overall fit statistics was satisfactory, indicating a good fit of the data to the model. The mean square fit measures for the items were close to the expected value of 1 in Rasch modelling. The infit t value of -0.50 and the outfit t value of -0.30 were also close to the expected value of zero. The estimate mean of item was zero by default with a *SD* of 0.57. The item separation reliability index of 0.97 was within the acceptable range (Bond & Fox, 2007). The overall fit statistics summary is shown in Table 5.12. The person fit measures were also in the acceptable range. The person infit mean square value of 1.00 and outfit mean square value of 1.02 were close to the expected value of 1. The infit and outfit t values of 0.00 and 0.10 were also near to the Rasch modelled value of zero. The person estimate mean was 0.18 with a *SD* of 0.53. The calculated person separation reliability index of 0.59 was low compared to the acceptable range (Bond & Fox, 2007). The Cronbach alpha reliability coefficient for persons was 0.62.

Table 5.12

Summary of the overall fit statistics for the achievement test data

Measure summary	Item		Person	
Mean (*SD*)	0.00 (0.58)		0.18 (0.53)	
Separation Index	0.97		0.59	
	Fit Statistics			
	Infit		Outfit	
	Mean square	t	Mean square	t
Item				
Mean	1.03	-0.50	1.02	-0.30
SD	0.42	4.20	0.41	2.70
Person				
Mean	1.00	0.00	1.02	0.10
SD	0.40	0.90	0.75	0.90

The variable map in Figure 5.12 shows the distribution of items and persons on the measurement logit scale. The items were represented by Item m (m=1to 10) on the right hand side based on the difficulty level. The persons were represented on the left hand side by x. The distribution of items and students indicated that, in general, this achievement test was fairly well matched to the students' ability. For further analysis, person ability measures were calculated.

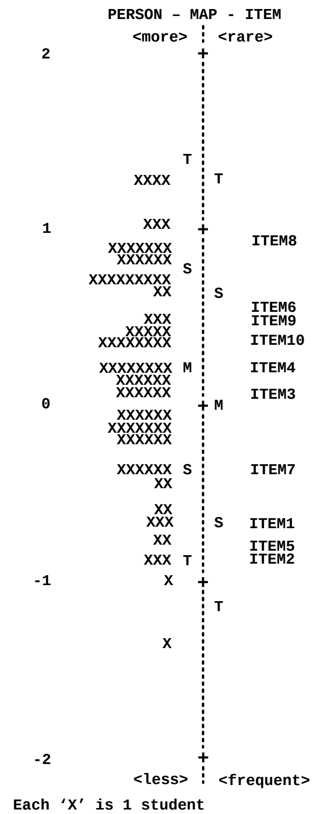


Figure 5.12. Variable map showing the distribution of items and persons for achievement test data

5.4 Analysis of multivariate normality results

Analysis of multivariate normality was conducted to establish the distribution of normality. The assumption of normality is essential in avoiding Type 1 error. Using SPSS version 21.0, the Mahalanobis distance details were generated for all the cases including all the dependent variables. From the residual statistics table generated by SPSS shown in Table 5.13, the maximum value for the Mahalanobis distance obtained was 25.89. This value was less than the critical value of 31.26 from the chi-square table indicating the absence of any multivariate outliers (Pallant, 2013), thus establishing multivariate normality.

Table 5.13

Details of Mahalanobis distance obtained for the variables in the study

	Minimum	Maximum	Mean	Std.Deviation	Number
Predicted value	-69.35	651.27	258.03	123. 815	106
Std. predicted value	-2.644	3.176	0.000	1.000	106
Standard error of predicted value	48.130	160.581	96.015	25.489	106
Adjusted predicted value	-136.86	591.36	252.17	129.029	106
Residual	-342.596	904.292	0.000	279.270	106
Std. residual	-1.161	3.064	.000	.946	106
Stud. residual	-1.273	3.213	.009	1.026	106
Deleted residual	-412.362	1057.674	5.858	329.154	106
Stud. deleted residual	-1.278	3.387	.021	1.057	106
Mahalanobis distance	1.801	30.089	10.896	6.369	106
Cook's distance	0.000	0.238	0.016	0.041	106
Centered leverage value	0.017	0.287	0.104	0.061	106

5.5 Multivariate analysis of variance results

Multivariate analysis of variance (MANOVA) tests were conducted with student gender as a between-subjects factor and the studied variables as the dependent variables. The first set of MANOVA was conducted with gender as a between-subjects factor and students' report of their general attitude towards maths and success in mathematics (sattitude), students' report of usefulness of mathematics (susefulness), students' report of their parents' attitude towards maths and child's maths study (sparentattitude), and parents' report of their own attitude towards maths and child's maths study (pattitude) as dependent variables. Gender was found to have a significant multivariate effect on the combined dependent variables, Hotelling's $T = 0.12$, F $(2, 103) = 2.94$, $p < 0.05$, ${\eta_p}^2 = 0.10$. However, follow-up univariate analysis of variance (ANOVA) on each dependent variable revealed no significant difference between boys and girls.

The next set of MANOVA was carried out with students' report of their maths anxiety (sanxiety), students' report of their confidence in learning mathematics (sconfidence), and students' report of their motivation (smotivation) as dependent variables and gender as between-subjects factor. Gender did not have any significant effect on the combined variables, Hotelling's $T= 0.03$, F (3, 102) = 1.14, *ns*, ${\eta_p}^2= 0.03$. There was no significant difference between the boys and girls in any of the dependent variables when considered independently.

The final set of MANOVA was conducted with student gender as a between-subjects factor and students' report of their parent behaviours in child's maths learning (sparentbeh), parents' report of their maths anxiety (panxiety), parent behaviours in their child's maths learning (pparentbeh), and parent expectation for their child's mathematics learning and future education (pexpectation) as independent variables. There was a statistically significant difference between boys and girls on the combined variables, Hotelling's $T= 0.13$, F (4,101) = 3.18, $p<0.05$, ${\eta_p}^2= 0.11$. Examining the results of the dependent variables separately, using a Bonferroni adjusted alpha value of 0.013, statistically significant difference was found between the groups in parent anxiety, $F(1, 104)= 8.77$, $p< 0.05$, ${\eta_p}^2= 0.08$. Fathers (M = 1.17, SD = 1.96) were found to report higher levels of anxiety than mothers (M = 0.29, SD = 1.09).

5.6 Results of multi-group analysis

5.6.1 Preliminary analysis

Descriptive statistics of all the variables in the study are shown in Tables 5.14. Table 5.14 shows the mean, standard deviation, skewness, and kurtosis of the variables in the study. The values of skewness varied from -0.03 to 1.68, showing small levels of skewness. The kurtosis values varied from -0.37 to 4.02, with panxiety (parents' report of their mathematics anxiety) having the highest value.

Table 5.14

Descriptive statistics of the variables in the study

	Mean	Std.deviation	Skewness	Kurtosis
sattitude	0.66	0.58	0.74	1.38
susefulness	0.80	0.93	0.81	0.24
sconfidence	0.48	0.92	0.23	-0.28
sanxiety	0.31	0.87	-0.23	-0.37
smotivation	0.37	0.64	0.77	1.65
sparentatttitude	1.26	0.97	1.09	0.90
sparentbeh	0.67	0.63	0.02	0.44
pparentbeh	1.21	0.98	-0.03	-0.22
panxiety	0.65	1.56	1.68	4.02
pexpectation	2.21	1.52	0.63	0.24
pattitude	1.80	1.83	1.12	2.49

Note: sattitude- students' report of their general attitude towards maths and success in mathematics, susefulness- students' report of usefulness of mathematics, sconfidence- students' report of confidence in mathematics, sanxiety- students' report of their mathematics anxiety, smotivation- students' report of their motivation, sparentattitude- students' report of their parents' attitude towards maths and child's maths study, sparentbeh- students' report of their parents' behaviours in child's maths learning, pparentbeh- parents' report of their behaviours in child's maths learning, panxiety- parents' report of their mathematics anxiety, pexpectation- parents' report of their expectation of child's mathematics learning and future education, pattitude-parents' report of their own attitudes to maths and child's maths study.

The correlations of the study variables for the overall sample and for the boys and girls in the study are shown in Table 5.15 and Table 5.16 respectively including means and standard deviations.

Table 5.15

Means, standard deviations and inter-correlations of the variables for the whole sample

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1. sattitude												
2. susefulness	.59**											
3. sconfidence	.65**	.63**										
4. sanxiety	.50**	.57**	.76**									
5. smotivation	.52**	.49**	.68**	.60**								
6. sparentattitude	.34**	.53**	.28**	.26**	.21*							
7. sparentbeh	.18	.25*	.15	.09	.09	.51**						
8. pparentbeh	.12	.24*	.03	.13	.04	.24*	.31**					
9. panxiety	.19	.16	.13	.16	.04	.18	.18	.39**				
10. pexpectation	.30**	.23*	.09	.15	.09	.31**	.16	.52**	.31**			
11. pattitude	.13	.27**	.14	.22*	.09	.30**	.23*	.48**	.23*	.48**		
12. achievementmeasure	.14	.10	.12	.20*	.25*	-.04	-.02	-.03	.16	.05	-.01	
13. *Mean*	.66	.80	.50	.31	.37	1.09	.67	1.28	.35	2.27	1.80	.19
14. *SD*	.58	.93	.92	.87	.64	.73	.63	1.09	1.01	1.54	1.18	.54

** $p<.01$ *$p<.05$

Table 5.16

Means, standard deviations and correlations of the variables for boys (above the diagonal) and girls (below the diagonal)

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
1. sattitude		.64**	.66**	.42**	.45**	.37*	.26	.19	.19	.40**	.22	.11	.61	.59
2. susefulness	**.60****		.62**	.54**	.36*	.57**	.32*	.24	.23	.30	.44**	.21	1.00	1.00
3. sconfidence	**.69****	**.63****		.76**	.69**	.35*	.43**	.16	.17	.20	.37*	.18	.66	.82
4. sanxiety	**.58****	**.60****	**.76****		.63**	.33*	.19	.32*	.24	.13	.44**	.30	.41	.67
5. smotivation	**.59****	**.61****	**.69****	**.61****		.17	.12	.13	.03	.17	.19	.26	.38	.70
6. sparentattitude	**.31***	**.52****	**.25***	**.24**	**.24**		.57**	.22	.18	.33*	.40**	-.01	1.06	.80
7. sparentbeh	**.12**	**.20**	**-.00**	**.05**	**.05**	**.46****		.18	.21	.17	.27	.19	.65	.65
8. pparentbeh	**.10**	**.17**	**-.12**	**-.01**	**-.05**	**.28***	**.45****		.46**	.60**	.49**	.22	1.60	1.16
9. panxiety	**.20**	**.07**	**.08**	**.12**	**.04**	**.19**	**.17**	**.31***		.49**	.12	.13	.51	.90
10. pexpectation	**.24**	**.14**	**.00**	**.16**	**.02**	**.29***	**.16**	**.43****	**.19**		.31*	.02	2.43	1.67
11. pattitude	**.08**	**.11**	**-.02**	**.10**	**.00**	**.23**	**.24**	**.45****	**.29***	**.61****		.07	1.96	1.21
12. achievementmeasure	**.17**	**.02**	**.08**	**.16**	**.24**	**-.06**	**-.16**	**-.22**	**.16**	**.07**	**-.07**		.21	.53
13. *Mean*	**.70**	**.66**	**.39**	**.24**	**.36**	**1.11**	**.68**	**1.07**	**.24**	**2.17**	**1.68**	**.17**		
14. *SD*	**.57**	**.86**	**.98**	**.97**	**.60**	**.69**	**.62**	**1.01**	**1.06**	**1.44**	**1.16**	**.56**		

** $p<.01$ *$p<.05$

All the student variables (sattitude, susefulness, sconfidence, sanxiety) were highly and significantly associated with each other at the 0.01 level. This result is not unexpected. The same result was seen when boys and girls are considered separately, although students' perceptions of the usefulness of mathematics is slightly less significantly associated with motivation for boys than it is for girls.

There are some differences, however, when the parent variables are considered. Students' perceptions of their parents' behaviour are significantly correlated with students' perceptions of usefulness overall, but this influence seems to be coming from boys rather than girls, for whom no significant association was seen. Students' perceptions of their parents' behaviour was also strongly associated with confidence for boys but not for girls. A similar finding was seen between parents' expectation and boys' attitudes to mathematics. These findings suggest that there may be different interaction patterns between parents and boys compared with girls. In particular, parents may have higher expectations for boys.

The correlations indicate that overall student anxiety and student motivation were significantly associated with mathematics achievement at the 0.05 level. Again this is not an unexpected finding. None of the other variable appeared to be significantly associated with mathematics achievement, although it is worth noting that students' perceptions of their parents behaviour and parents' reports of their behaviour appear to be negatively associated with girls' achievement, and positively associated with boys' achievement. Again the students' perception of their parents' attitude to mathematics and parents' reports of their attitude to mathematics were negatively associated with girls' achievement, and for the boys students' perception of their parents attitude to mathematics was negatively associated with their achievement, but parents' reports of their attitude to mathematics were positively associated with their achievement, though none of these associations were significant.

5.6.2 Measurement model testing

The measurement model (see Chapter 4, Figure 4.3) was first tested before testing the structural model. The latent variable, mathematics anxiety, was measured by three indicators: students' report of their anxiety (sanxiety), their confidence in learning mathematics (sconfidence), and their effectance motivation (smotivation). The second latent variable, attitude towards mathematics, was measured by four indicators namely, students' report of their general attitude towards maths and success in mathematics (sattitude), students' report of the usefulness of mathematics (susefulness), students' report of their parents' attitude towards maths and child's maths study (sparentattitude), and parents' report of their own attitude towards maths and child's maths study (pattitude). Lastly, the latent variable, parental involvement, was measured by a set of four indicators, students' report of their parents' behaviours in child's maths learning (sparentbeh), parents' report of their own behaviours in child's maths learning (pparentbeh), their mathematics anxiety (panxiety), and expectations of their child's mathematics learning and future education (pexpectation). The Rasch person estimates for each of the variables were used in this analysis.

As explained in detail in Section 4.8 in Chapter 4, a measurement model was tested for invariance using multi-group confirmatory factor analysis (MGCFA). The MGCFA was conducted in the sequence of configural invariance, metric invariance, scalar invariance, and invariance of latent means. Configural invariance required an identical factor structure across the two groups. Metric invariance needed the same factor loadings across the groups considered. Scalar invariance required invariant factor loadings and intercepts across the two groups. Lastly, latent mean differences were tested by constraining the latent mean for the male group to zero as the male group was kept as the reference group (Hancock, 1997). The model fit was assessed by examining the relative chi-square (i.e., χ^2/df) value, as the chi-square values were sensitive to sample size (Byrne, 2001; R. B. Kline, 1998). In addition, the comparative fit index (CFI) and the root mean square error approximation (RMSEA) were used to assess the overall fit of the model. A CFI value of 0.95 or greater (Hu & Bentler, 1999), and an RMSEA value of 0.08 or less was considered as a good fit of the model (Browne & Cudek, 1993). In the case of nested models, difference in CFI (i.e., ΔCFI) was considered to evaluate the fit of the models (G. W. Cheung & Rensvold, 2002). A non-significant change in CFI (ΔCFI) with a value of less than 0.01 was used for testing the invariance (G. W. Cheung & Rensvold, 2002).

The hypothesised measurement model was first tested for configural invariance. That is, the model was tested to check whether the factor structure was identical for both boys and girls. The model provided a poor fit with fit values, $\chi^2(98) = 196.98$, $p = 0.00$, $\chi^2/df = 2.0$, CFI = 0.79, RMSEA = 0.098 (90% CI = 0.078, 0.118). The indicators students' report of their parent attitude towards maths and child's maths study and the parents' report of their attitude towards maths and child's maths study were removed due to poor factor loadings. The resultant measurement model was then evaluated and the model provided an acceptable fit, χ^2 (60) = 76.36, $p< 0.10$, $\chi^2/df = 1.27$, CFI = 0.96, RMSEA = 0.051 (90% CI = 0.000, 0.083). All factor loadings showed identical pattern across boys and girls. Thus configural invariance has been established, showing that the model has the same factor structure for both boys and girls. The modified measurement model showing the relationship between the observed variables and the latent variables is shown in Figure 5.13.

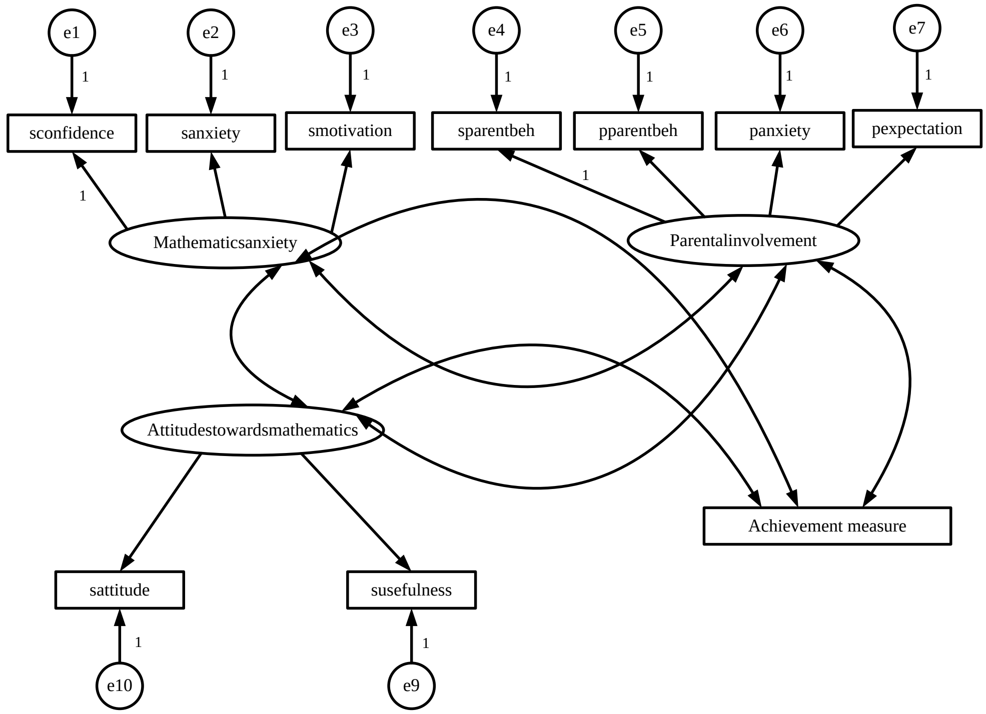


Figure 5.13. The modified measurement model showing the relationship between the observed variables and the latent variables

The modified measurement model was next tested for metric invariance, where all the factor loadings were constrained to be equal for both boys and girls. The model fit was acceptable, χ^2 (66) = 86.67, p < 0.05, χ^2/df = 1.31, CFI = 0.94, RMSEA = 0.055 (90% CI = 0.009, 0.084). The differences in fit values between the configural and metric invariance model were significant, $\Delta\chi^2$ (6) = 10.31, p< .001 ΔCFI = 0.01 (G. W. Cheung & Rensvold, 2002), showing that the full metric invariance was not established, indicating that all the items did not have the same relative contribution to the measure across the two groups. Consequently, partial metric invariance was tested by freely estimating the factor loadings one by one. The analysis yielded acceptable fit for the model, χ^2(63) = 78.91, p= 0.10, χ^2/df = 1.25, CFI = 0.96, RMSEA = 0.049 (90% CI = 0.000, 0.080) where the factors loadings of students' report of their motivation, parents' report of their mathematics anxiety and expectation of their child's mathematics learning and future education were variant across groups of boys and girls. The differences in the fit values between this model and the configural invariant model were not significant, $\Delta\chi^2$ (3) = 2.55, *ns*, ΔCFI = 0.00 (G. W. Cheung & Rensvold, 2002), indicating that partial invariance was achieved.

The next step in the testing of the measurement model was to test for scalar invariance. Scalar invariance was tested with the factor loadings and intercepts equal across both groups. The model fit was acceptable, χ^2 (72) = 102.75, $p < .010$, χ^2/df = 1.43, CFI = 0.92, RMSEA = 0.064 (90% CI = 0.032, 0.091). The differences in the fit values between the scalar invariant model and the partial metric invariant model were significant, $\Delta\chi^2$ (9) = 23.84, p<.001, ΔCFI = 0.04 (G. W. Cheung & Rensvold, 2002), showing that the full scalar invariance was not supported. Therefore, partial scalar invariance was evaluated by freely estimating the intercepts one after another. The fit values of the final model were good, χ^2 (69) = 84.89, $p = 0.10$, χ^2/df = 1.23, CFI = 0.96, RMSEA = 0.047 (90% CI = 0.000, 0.078), where the intercepts of students' report of their general attitude towards maths and success in mathematics, parents' report of their anxiety, and parents' report of their behaviours in their child's maths learning were variant across the groups. Thus, partial scalar invariance was achieved based on the non-significant change in the fit indices, $\Delta\chi^2(6)$ = 5.98, *ns*, ΔCFI = 0.00 (G. W. Cheung & Rensvold, 2002).

Once partial scalar invariance was established, the model was tested to examine whether the latent construct means were different across the two groups. The invariance of latent means was achieved by fixing the latent means for the boys to be zero. The fit values obtained showed a good fit, $\chi^2(66)$ = 81.05, *ns*, χ^2/df = 1.23, CFI = 0.96, RMSEA = 0.047 (90% CI= 0.000, 0.078). The changes in fit values between this model and the partial scalar invariant model were non-significant, $\Delta\chi^2$ (3) = 3.84, *ns*, ΔCFI = 0.00 (G. W. Cheung & Rensvold, 2002), showing that all the latent means were invariant for the groups.

5.6.3 Structural model testing

After establishing an acceptable measurement model, the next step was to test structural invariance across the groups. Testing of structural invariance involved examining whether the hypothesised structural paths were invariant for boys and girls. In the first model, all the regression paths across the latent factors were freely estimated. The fit of this model to the data was good, χ^2 (66) = 81.05, *ns*, χ^2/df = 1.23, CFI = 0.96, RMSEA = 0.047 (90% CI=0.000, 0.078). This baseline model was then compared with a fully constrained structural model where all the paths were constrained to be equal across the two groups. The fit of the fully constrained model was good, χ^2 (71) = 86.52, *ns*, χ^2/df = 1.22, CFI = 0.96, RMSEA = 0.046 (90% CI = 0.000, 0.076). The fit value differences between the baseline model and the full structural model were not significant, $\Delta\chi^2$ (5) = 5.02, *ns*, ΔCFI = 0.00 (G. W. Cheung & Rensvold, 2002), indicating that all the structural paths were invariant for both boys and girls. The unstandardised regression coefficients enable researchers to compare the strength of one effect across multiple groups, whereas the standardised regression coefficients enable researchers to compare the strength of the effects of various predictors on the dependent variable within the same group. Thus, it would be wise to display unstandardized regression coefficients to compare effects of given variables across groups (R. B. Kline, 2010). The final structural model with unstandardised regression coefficients is shown in Figure 5.14.

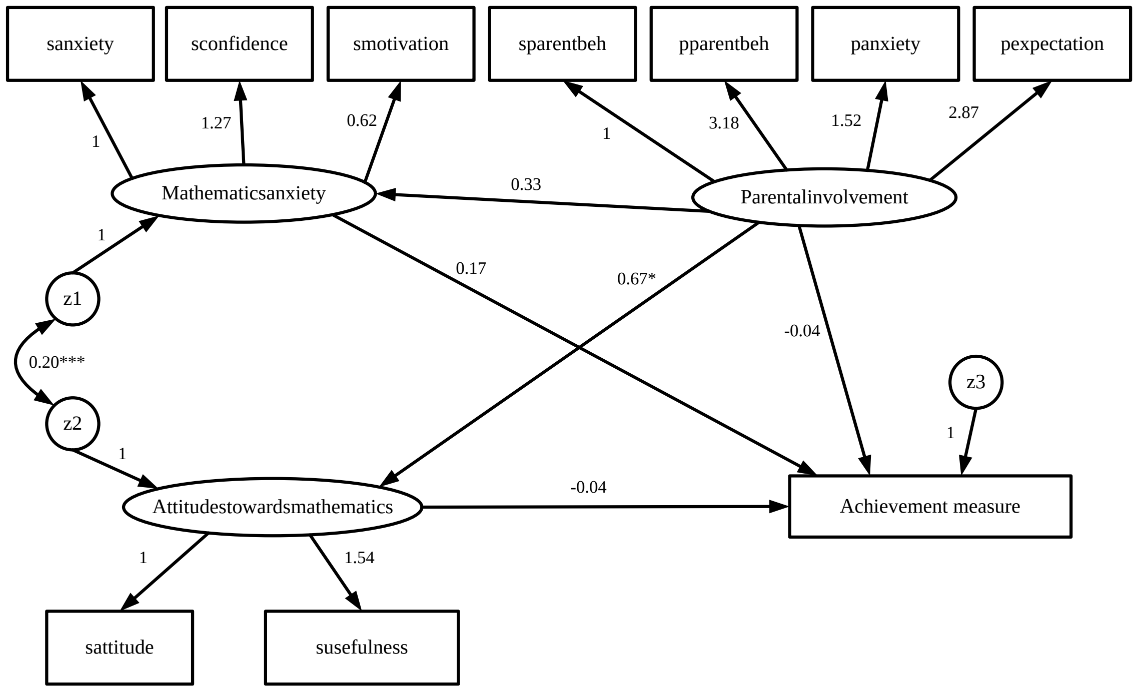


Figure 5.14. Structural model showing the relationship between the variables in the study

Figure 5.14 indicates that parental involvement was significantly and positively associated with attitude towards mathematics but had no significant association with mathematics anxiety. A significant positive correlation was found between mathematics anxiety and attitude towards mathematics. The relationship between parental involvement and mathematics achievement was non-significant. Mathematics anxiety was not significantly associated with mathematics achievement. The association of attitude towards mathematics and achievement in mathematics was not significant either.

The previous section presented the results from multi-group analysis. The multi-group analysis included evaluation of the measurement model as well as the structural model. The next section presents the findings from the interview data of the study, which complement the quantitative results.

5.7 Findings from the qualitative data

This section describes the findings from the interview data of the study. The qualitative results were used to complement the quantitative findings of the study. The results are presented in the order of the major themes identified. The results of the interview data were presented under the headings of the variables of interest as the researcher found it best to present the findings from the qualitative data. Certain themes like future ambition, teacher, and maths course were mentioned by just one or two parents. They were, therefore, not used to explain the findings of the study even though these themes were identified during the analysis of the data.

Based on the achievement scores and described in subsection 3.9.2 of Chapter 3, the students were grouped as high achievers, average achievers, and low achievers. From those students who consented, a total of twelve pairs (a student and a parent of each) from the three groups were selected for the interview. Finally, six pairs comprising a student and his/her father or mother were interviewed for the study. The student and one parent were interviewed at their residence separately. The student interviews were approximately 30 minutes in duration and the parent interviews approximately 20 minutes. The interview participants were Maya and her father Baby, Meenu and her mother Jaya, Tony and his mother Jane, Mary and her mother Lizy, Hema and her mother Rani, and Honey and her father Mathew. Except for Mary and Honey, either father or mother chose to be present during the student interview. All the names used here are fictitious, to protect the identity of the participants. The findings from the interview data of each student-parent pair are presented in the following sections in the order in which they were interviewed.

5.7.1 Maya and her father Baby

When Maya was interviewed, she was 14 years old and was studying in Year 9. She was the youngest child in her family and had an older brother. Her father was a public servant and her mother was a housewife. Her score in the mathematics achievement test in for this study was very poor. She scored in the bottom 20% in the test for this study. Maya's father, Baby, was present during her interview.

5.7.1.1 Attitude towards mathematics.

Maya rated herself as an average student in mathematics. She admitted that her understanding of mathematics was not good and that she found the subject hard. She said, "I don't know mathematics very much. But I am not bad in maths." In her opinion, mathematics was an important subject, which was clearly expressed in her words; "I think mathematics in important in my future work." Her father also had similar views about mathematics. He said, "Mathematics is the most important subject. I always ask my children to work hard in mathematics." Maya named English as her worst subject in the school. She was also of the opinion that a lot of hard work was needed to succeed in mathematics.

5.7.1.2 Mathematics anxiety.

Maya admitted that she was always nervous during mathematics tests but she was confident that she could do better if she worked hard. She said, "I can do better, I could."

5.7.1.3 Parental involvement.

When Maya was asked about her parents' involvement in her mathematics home work, she replied that her parents never helped with or checked her home work but, her older brother helped her with her home work and other activities related to mathematics.

Baby said that as parents he and his wife regularly monitored Maya's mathematics progress. Baby was not directly involved in the mathematics learning of his daughter. He said, "What I meant by helping is that .... I can't help by teaching them maths, but ..... I help them in other ways." Baby also said that he had arranged extra tutoring for Maya because he was unable to help with Maya's mathematics study. He allotted and monitored the time Maya spent on other activities like watching TV. Only Saturdays and Sundays were allotted for activities outside of studies. Maya's parents were not directly involved in helping her with her mathematics learning, but they provided extra tutorial support and encouraged her to work hard to do well. Maya said that her parents were strict with her because she had much to study. Maya appreciated her parents' expectations and was eager to improve her results.

In relation to attendance of parent teacher meetings, Baby said that he consulted Maya's teachers only when they received her progress report. He also indicated that he encouraged Maya to do well in mathematics. In his words, "I'm encouraging her to get more marks and to improve in maths." Baby said he expected Maya to achieve well in school and Maya confirmed this, saying that her parents expected her to do all questions in mathematics and score top marks. Maya said that she would work hard to achieve her ambition to be a doctor. Baby added that he would help Maya in all respects to achieve her goal which was emphasised in his words, "My daughter's ambition is to become a doctor. I will help her for that." He also said, "I used to enquire my children's opinion and I gave priority to their opinion. I won't force them to choose my opinion. Their opinion was important."

5.7.2 Meenu and her mother Jaya

Meenu was 16 years old studying in Year 11 at the time of the interview. Her father was a public servant and her mother worked as a school teacher. She had an older brother studying engineering. She scored in the top 15% in the achievement test for this study. Meenu's mother, Jaya, was present during her interview.

5.7.2.1 Attitude towards mathematics.

Overall Meenu considered mathematics an easy subject, but she found certain topics and problems difficult to understand and would skip those topics. She said "I find it difficult to study that ..... those portions like geometry, calculus." When asked whether mathematics was useful for future work, Meenu was unable to give an answer. She was also of opinion that students need to work hard in mathematics. Meenu rated history as her worst subject.

5.7.2.2 Mathematics anxiety.

It appeared that Meenu had difficulty with mathematics examinations. She said that her mind went blank during mathematics tests and she forgot the equations and formulas to solve the problems. She said "I feel .... I feel my mind went blank and I'll forget all the equations ...." Meenu added that she found it difficult to complete a whole test in the time allowed, although she knew how to solve the problems.

5.7.2.3 Parental involvement.

Meenu indicated that her parents didn't check her home work or help with her mathematics work, but they had arranged extra tutoring for her in mathematics. Jaya explained that she asked Meenu to work out problems in mathematics repeatedly rather than learning it by heart. Jaya said, "I used to tell her only if you repeatedly do the problems in maths it would be easy for you. She had a tendency to study by-heart, but as I've advised her to study by doing, she is not studying by-heart anymore. She studies well for the exam, but she makes mistakes." Jaya said that she was unable to teach Meenu higher mathematics, only the basics. She also admitted that nobody in the family was an expert in mathematics.

Jaya explained that she monitored the time Meenu spent on activities other than studies, especially the time Meenu spent on the internet as well as what she watched on it. She had even prepared a timetable for Meenu. When Meenu was asked why her parents monitored the time she spent on watching TV or internet, she was reluctant to answer the question. But eventually she said, "How can I say that?" Meenu may have felt that her mother wouldn't like her talking about their supervision. When asked about consultations with her daughter's teachers, Jaya said she met them when Meenu received her progress reports. Jaya indicated that she did not compel Meenu to study, but advised her to work hard to achieve her desire. She added that they would give Meenu freedom to choose the subjects of her interest after Year 12. Meenu said that her parents expected her to achieve more than 90% in mathematics and to become a doctor. Jaya talked more about the inefficiency of Meenu's teachers than her daughters' achievement. Jaya was of opinion that Meenu's maths teacher was not effective in clearing the doubts of the students. She said that maths teachers at her daughter's school were not good. Meenu's parents expected her to achieve high scores in mathematics and to become a doctor. Their expectations were communicated to Meenu through consistent reinforcement.

5.7.3 Tony and his mother Jane

Tony was 14 years of age, studying in Year 9 when he was interviewed. His father was an electrician and his mother was a housewife. Tony had an older sister studying engineering. He scored in the bottom 25% in the achievement test in mathematics for this study. Jane, Tony's mother, was present during his interview.

5.7.3.1 Attitude towards mathematics.

Tony considered mathematics a useful subject. He said that mathematics was important in day-to-day life for buying things. Tony rated himself as an average student in mathematics and was confident that he could improve his results. He considered his worst subject in school to be social sciences.

5.7.3.2 Mathematics anxiety.

Tony admitted that he felt anxious during mathematics tests and made mistakes because of his anxiety. As a result he had to redo the questions and at times he was unable to complete tests on time.

5.7.3.3 Parental involvement.

Tony said that his parents didn't help with his mathematics study, but they had arranged extra tutoring for him. Tony said his parents never checked his home work, but Jane said that she checked his home work each week. She said, "I used to check his maths marks because it is important for their future studies." She was of opinion that Tony had to improve his mathematics performance, and she consulted Tony's teachers once every 2 months to discuss his performance in mathematics. Jane indicated that she gave advice to her son to study well, and that she monitored his activities. Tony had a set timetable for watching TV, playing games and for socialising. Jane also mentioned that her son thought that she over advised him.

Tony's ambition was to become a doctor. When asked about the reason behind his choice, Tony replied that his only reason was the salary. Tony was unable to answer the question about his parents' expectations, but Jane indicated that they didn't have any particular profession for Tony in their mind. They were willing to support Tony in whatever interested him. She said, "It's up to him, because he should learn what he is interested in. It's not our interest, it's their interests." They expected him to work hard in whatever he chose. Tony's parents consistently communicated to him the importance of working hard in all subjects and having high achievement.

5.7.4 Mary and her mother Lizy

Mary was 16 years of age at the time of interview and was studying in Year 11 and was the only child in her family. Her mother was a clerical assistant in a government organisation and her father was a public servant. She scored in the top 15% in the achievement test for this study. Neither Mary's mother nor father was present during her interview.

5.7.4.1 Attitude towards mathematics.

Mathematics was an easy subject for Mary and she rated herself as a good student in mathematics. She considered mathematics as a useful subject that is helpful in day-to-day living, in studying other subjects, and for developing problem solving ability. History was considered by Mary to be her worst subject in school.

5.7.4.2 Mathematics anxiety.

Mary admitted that she was not nervous during mathematics tests. She said, "I'm not at all nervous while writing the exam. I felt quite normal." She was confident that she could score more than 80% in mathematics.

5.7.4.3 Parental involvement.

Mary indicated that neither of her parents helped her in her mathematics study nor checked her mathematics homework. However, Lizy said she checked Mary's homework daily. She said that she was not able to teach Mary mathematics, but only science subjects. Mary said that her parents had arranged extra tutoring in mathematics for her. Mary said that her tuition master, her mathematics teacher, and her friends helped her in mathematics study. Lizy indicated that she was involved in all aspects of her daughters' study. She said, "I'm involved in all the activities of my child in the school. I used to buy the books required for her studies and I also went to the school and contacted the teachers about her progress."

Lizy was satisfied with her daughter's performance in mathematics. She said that Mary scored good marks in mathematics and was doing well in the subject. Mary also indicated that her parents were satisfied with her achievement. Mary's parents supervised her non-academic activities. They had given her permission to watch TV for 2 hours only on weekends and to socialise with friends. In Mary's opinion her parents wanted her to work hard to achieve A's and A+'s in her studies. When asked about her ambition, Mary replied that she wanted to become a doctor. She explained that her parents also expected her to choose the profession of a doctor. She said, "It is my mother. She love ... she says that she ... she wanted to become a doctor, but she can't do that, she can't do it, but she is asking me, I'm not telling that she is ... She wanted to become a doctor, but she can't ..." Lizy also expressed her desire for Mary to become a doctor, saying, "I don't have any particular desire. She wishes to join medicine. I support that. When I was a student I too wished to become a doctor, but I couldn't. I don't compel her to become such and such, but from her earlier days I managed to generate an ambition in her. So now she is interested in going to medicine." Mary's mother communicated her expectations and attitudes to Mary through strict supervision of her behaviour.

5.7.5 Hema and her mother Rani

Hema was studying in Year 11 and was 16 years old at the time of the interview. Her father was working in the Middle East and her mother was a house-wife. She had one older brother. Hema was an average student in mathematics and her score in the mathematics achievement test for this study was close to the mean. Hema's mother, Rani, was present during her interview.

5.7.5.1 Attitude towards mathematics.

Hema considered mathematics as an interesting subject and rated herself as an average student. She added that she liked to do maths and found it interesting. She regarded mathematics as a useful subject, helpful in everything she did. Mathematics was the most difficult subject for Rani, but she indicated that mathematics was important as it helped in securing jobs in the banking or engineering sector. Hema considered Physics as her worst subject in school. She explained that she was unable to understand anything in Physics. When asked whether her difficulty in Physics was because of mathematical problems in the subject, she replied that it was due to the method of teaching.

5.7.5.2 Mathematics anxiety.

Hema said that she was not at all anxious during mathematics test. Her mind was free during the test and was confident in her mathematical ability. She said, "If I study then I can write it well."

5.7.5.3 Parental involvement.

Hema's mother had been able to help Hema with mathematics work until Year 8. From Year 9 her parents arranged extra tutoring for her in mathematics. Her teachers and friends also helped her with mathematics work. Rani said she would check Hema's homework, but now she was not doing it daily. Instead, Rani supervised the overall activities of her daughter. She said, "I watch all activities of my child. During exam times we monitor her a lot. I used to check her homework before, but nowadays I don't check her homework daily. I tell her to study maths thoroughly and to go to school and talk to the teachers." She also encouraged Hema to finish all her assignments in time.

Rani seemed not to be satisfied with Hema's recent performance in mathematics. She said that her daughter was not spending enough time in learning mathematics, but was interested in watching TV and socialising with friends. Hema's ambition was to become a doctor or an engineer. She explained that she liked computer engineering very much and at the same time she liked to help others. But Rani expected Hema to score above 80% in Year 12 and to get a government job in future. Though Hema wanted to be a doctor or an engineer, she also agreed with her mother. She mentioned, "nowadays medicine and engineering, they are not at all that valuable, I think nowadays they are ... they're easily available. I think ... I think so, and if we get a government job then we can ... we can ... it will be a permanent one." Her parents consistently communicated their expectations and attitudes to her and had put in place practices that helped Hema to work hard.

5.7.6 Honey and her father Mathew

Honey was 13 years of age and was studying in Year 9 when she was interviewed. She was the only child in her family. Her father was a public servant and her mother was a housewife. Honey was an average student in mathematics and her score in the achievement test in mathematics for the study placed her in the average achievement category. Neither Honey's father nor mother was present during the interview.

5.7.6.1 Attitude towards mathematics.

Honey rated herself as an average student in mathematics. She considered mathematics to be an important subject if one was good at it. Mathew thought that Honey was not good at mathematics. He said, "For maths, she is not that good. So I've a little tension about it." Honey rated chemistry as the most difficult subject for her in school.

5.7.6.2 Mathematics anxiety.

Honey admitted that she felt tense while taking mathematics tests. She said she found it difficult to do the tests because she forgot what she had studied. She explained that when she sat for a mathematics examination, her mind would go blank and she was not able to do well in the examination. She was not satisfied with her own performance.

5.7.6.3 Parental involvement.

Honey's parents were not much involved in her mathematics learning. She said that her parents didn't check her homework or help her with mathematics work, but they always insisted that she finished her homework and learned mathematics. Mathew admitted that he was not involved in his daughter's mathematics studies, but he could teach her social sciences. He said he did not have enough time to help her and indicated his inability to teach higher mathematics. Mathew added that his wife helped Honey more than he did with the school subjects. When asked about her parent's behaviours in monitoring activities other than studies, Honey said, "always telling me to study. Don't watch TV all time. Because studying is very important".

Honey's parents had arranged extra tutoring in mathematics and Honey said that tuition teacher helped her with mathematics. Mathew explained that, "For maths, she is not that good. So I've a little tension about it, but I can't teach her maths. So I've arranged tuition for maths and tell her to study well on maths." Honey also admitted that her parents were not happy with her performance in mathematics. When Honey received her progress reports Mathew would consult Honey's mathematics teacher and discuss her performance. Mathew expected his daughter to study well according to her interests. He also added that not everyone can become an engineer or a doctor or reach high administrative positions. He wanted his daughter to have a good job. Honey also talked about her parents' expectations in a similar way. She said, "My father use to say he doesn't have any specific desires. He says I should get a good job, I need to stand on my own feet, and that's all." Her father had communicated his expectations and attitudes to her consistently through his parenting behaviours.

5.8 Summary of the findings from the qualitative data

Overall the students indicated mathematics was a useful subject. They agreed that mathematics was helpful in the study of other subjects and also in securing a good job for the future. The students expressed mixed feelings about their performance in mathematics. For example, four of the six students interviewed, Maya, Tony, Hema, and Honey, rated themselves as average students in mathematics. The actual performance of Maya, Tony and Honey on the achievement test used in the study were below average. Meenu and Mary rated herself as an above average student in mathematics and Meenu, Mary and Hema performed in the above average category in the subject according to the test used in this study. The achievement test results in the study for Meenu and Mary were consistent with their own estimation of their ability in mathematics.

Students had mixed reactions when asked about their mathematics anxiety. Maya admitted that she was nervous during mathematics tests. Meenu also reported experiencing difficulty during mathematics tests. Mathematics anxiety affected her to the extent that during mathematics tests she forgot the formulas and equations. Nevertheless, she was able to score above 80% in mathematics. The same was expressed by Tony who added that he made mistakes in mathematics tests because of anxiety. As for Honey she said she forgot everything she learned while attempting a mathematics test. On the contrary, Mary and Hema were never nervous during mathematics tests.

None of the parents were directly involved in the mathematics learning of their children. All the parents found it difficult to teach the secondary mathematics content. Mary's mother mentioned that she was able to help her daughter with science subjects and Mathew, Honey's father, helped her with social science. None of the parents were involved in checking homework or helping their children with mathematics work. In all cases, it was their older siblings, teachers, friends or tuition masters who helped the students with mathematics.

All the parents wanted their children to work hard and achieve their best in studies. They instilled their beliefs and expectations to the children in a similar fashion. They had communicated to their children that studies were important, encouraged their children to work hard, score good marks and secure a good job. All of the parents expected their children to achieve highly in mathematics. They tended to be strict and observant of their child's extra-curricular activities. All of the parents who were interviewed strictly limited their children's time spent watching TV, engaging in online activities, and socialising with friends. In Maya's case only Saturdays and Sundays were allotted for extra-curricular activities and Meenu had permission to watch TV only for 2 hours during weekends. Hema and Tony had a time table for activities outside their studies. Only one of the parents consulted their child's mathematics teacher other than when progress reports were received. The parents expressed their willingness to support their children in the pursuit of their dream.

5.9 Conclusion

This Chapter has presented the results of the study from quantitative and qualitative data obtained. The empirical model (see section 5.6.3) showed that parental involvement has a significant positive relationship with attitude towards mathematics. No significant association was observed between mathematics anxiety and parental involvement. Mathematics anxiety and attitude towards mathematics were found to be positively correlated. The model also showed that none of the variables had a significant relationship with the mathematics achievement of the students. No gender differences were observed in any of the variables studied. From the qualitative data, it was found that parents expressed high expectations about their children's education and future career and the students were mindful of these. The next chapter, Chapter 6, discusses the findings of the study in relation to the research questions defined in Chapter 1 based on the conceptual framework presented in Section 1.2 in Chapter 1 and shown in Figure 1.1.

CHAPTER 6 DISCUSSION AND CONCLUSION

6.1 Introduction

As discussed in Chapter 2, previous research has demonstrated the importance of mathematics achievement for secondary school students in relation to tertiary mathematics success, achievement in science subjects, future career choices, and quality of life (Halpern et al., 2007; Murrane et al., 1995). Nevertheless, the number of students opting for the most demanding mathematics courses and mathematics related subjects at the higher secondary level has declined in many countries (e.g., Goodrum, Druhan, & Abbs, 2011; Lowell & Salzman, 2007; Schleicher & Ikeda, 2009; Smith, 2011). India has also experienced a decline in the number of graduates choosing mathematics related career options (e.g., Garg & Gupta, 2003; Mishra, 2011).

A majority of the research studies on mathematics anxiety, attitude towards mathematics, and parental involvement as factors influencing mathematics achievement have been carried out in western contexts. There is a dearth of such studies on these variables among Indian students, particularly at the secondary level. Furthermore, in research to date, the variables mathematics anxiety, attitude towards mathematics and parental involvement have been studied separately to understand the influence of each on mathematics achievement, and in pairs to understand their interaction with each other or their combined effect on mathematics achievement. There appear to be no studies conducted among secondary school students that combine variables mathematics anxiety, attitude towards mathematics, and parental involvement, and particularly in India. This study investigated the influence of Indian secondary school students' mathematics anxiety, attitude towards mathematics, and parental involvement on their mathematics achievement. Additionally, the study investigated the inter-relationships among these constructs and the effect of gender on these relationships.

6.2 Overview of the findings of the current study

This chapter begins with a brief overview of the study's findings in comparison with those of other studies. Subsequent sections address each of the research questions in turn. These were:

1. How does parental involvement in learning influence mathematics achievement of secondary school students in India?

2. How does attitude towards mathematics influence mathematics achievement of secondary school students in India?

3. How does mathematics anxiety influence mathematics achievement of secondary school students in India?

4. How do parental involvement, attitude towards mathematics and mathematics anxiety interact to influence the mathematics achievement of secondary school students in India?

5. Are there gender differences in relation to any of these variables and/or their relationships?

The study found that mathematics anxiety was not significantly associated with mathematics achievement of the students. The association of attitude towards mathematics and achievement in mathematics was also not statistically significant. These findings of the non-significant relationship of mathematics anxiety to achievement in mathematics, and attitude towards mathematics to achievement in mathematics are not in agreement with majority of the findings in the broader research context. For example, the non-significant relationship between mathematics anxiety and mathematics achievement contradicts the findings of H. Z. Ho et al. (2000) and Woodard (2004), who found a significant negative association between mathematics anxiety and achievement in mathematics. Other researchers have observed a significant positive relationship between attitude towards mathematics and mathematics achievement (e.g., Nicolaidou & Philippou, 2003; Singh et al., 2002).

The inconsistencies in the relationship between mathematics anxiety and mathematics achievement, and between attitude towards mathematics and mathematics achievement in the present study and the above mentioned studies could be due to the differences in the conceptualisation and measurement of the constructs, or the participants. For instance, the current study looked at the relationship between mathematics anxiety and achievement in mathematics among Year 9 and Year 11 students in India. Mathematics anxiety was measured by students' perception of their anxiety, their confidence in learning mathematics, and their motivation, and parents' perception of their own mathematics anxiety in this study. An achievement test in mathematics measured the mathematics performance of the participants. Ho and his colleagues (2000) in their cross-national study compared the dimensions and levels of mathematics anxiety and its association with mathematics achievement among 6^{th} graders in China, Taiwan, and United States. Mathematics anxiety was measured using the 11-item Maths Anxiety Questionnaire (MAQ) representing the cognitive and affective dimensions of the construct. Mathematics achievement of the participants was measured using a mathematics test comprising two forms (Test 1 & Test 2), administered within a gap of 4-6 weeks. Woodard (2004) studied the relationship between mathematics anxiety and achievement in mathematics among undergraduate students in the US and the differences in mathematics anxiety in terms of gender and age, using the 98-item Mathematical Anxiety Rating Scale(MARS).

In assessing the relationship between attitude towards mathematics and mathematics achievement,the current study measured attitude towards mathematics in terms of students' perception of their general attitude towards maths and success in mathematics, and their perception of usefulness of mathematics, students' perception of their parents' attitude to maths and their child's maths study, and parents' perception of their own attitude to maths and child's maths study. The mathematics performance of the participants was measured using an achievement test in mathematics. In the Nicolaidu and Philippou (2003) study, attitude towards mathematics was measured using three scales: an eleven point scale measuring their attitudes, a scale of five pictures measuring expressions about the subject, a third scale of 5-point Likert-type statements measuring feelings towards the subject. The participants' problem solving ability was measured using a combination of ten word-problems, nine routine problems, and one procedure problem. On the other hand, Singh and her colleagues in their 2002 study measured the construct using three items asking the participants their preparedness to maths class, usefulness of maths in future, and their interest in the subject. The participants in Nicolaidu and Philippou (2003) study were fifth grade students and Singh et al. (2002) study were eighth graders, whereas the participants of this study were Year 9 and Year 11 students in India.

In this study, the relationship between parental involvement and mathematics achievement was non-significant. This is inconsistent with the results of studies that have found a positive association between specific parental involvement activities such as parent-child communication and parental encouragement in mathematics learning and mathematics achievement (X. Fan & Chen, 2001; Jeynes, 2005). The inconsistencies in the results may be due to the fact that in Fan and Chen (2001) study parental involvement was indicated by parental aspiration/expectation for their child's educational achievement, and parental home supervision and in Jeynes (2005) study the construct was conceptualised as parental communication, and spending time with their children, parental style, parental expectations, and parental involvement in school activities. Whereas in the present study, parental involvement was conceptualised in a broader sense in terms of parental participation in school-related activities (such as monitoring of home study and attending parent-teacher interviews), parental encouragement of academic success, and parental expectations of educational attainment and parenting style.

The results of the present study is also inconsistent with that of Catsambis (1988) who reported a negative association between academic achievement of eighth graders and parental involvement indicated by parents' supervision of their children's academic and behavioural activities (e.g., maintaining good grade average, doing chores at home, completing homework) using National Educational Longitudinal Study of 1988 (NELS:88) data. In 2008, in a research synthesis of studies of parental involvement in homework, Patall, Cooper, and Robinson (2008) found a negative association between parental involvement in home work and mathematics achievement in the three studies that used either National Educational Longitudinal Study (NELS:88) data or any one of the National Educational Longitudinal Study (NELS) follow-up data on the same sample (in 1990, 1992, 1999, or 2000). In addition, they also found a negative relationship between parental involvement in homework and mathematics achievement in the meta analysis of another set of correlational studies in the synthesis (Patall, Cooper, & Robinson, 2008). Thus there is inconsistency in the results in relation to parental involvement and mathematics achievement. In both cases Patall, Cooper, and Robinson (2008) assessed how parental involvement in homework influenced mathematics achievement. The present study used a broader conceptualisation of parental involvement as explained in Chapter 1, section 1.2.3.

A significant positive correlation was found in the present study between mathematics anxiety and attitude towards mathematics which is inconsistent with most of the research findings in the literature. For example, this finding contradicts the finding of a negative correlation between mathematics anxiety and attitude towards mathematics by Durrani and Tariq (2009) and Kargar, Tarmizi, and Bayat (2010). The participants in the present study were Year 9 and Year 11 students, whereas Durrani and Tariq's (2009) and Kargar et al. (2010) studies involved undergraduate students. The contradictory findings could also be due to the differences in the measurement of the constructs. Durrani and Tariq's (2009) study measured mathematics anxiety using three subscales namely maths text anxiety , numerical task anxiety, and maths course anxiety. Kargar and his colleagues (2010) used two subscales namely, Learning Math Anxiety scale and Math Evaluation Anxiety scale to measure the construct. The current study used the subscales the Anxiety scale, the Confidence in learning mathematics scale, the Effectance motivation in mathematics scale and Parent maths anxiety scale. In measuring attitude towards mathematics, Durrani and Tariq's (2009) study used four subscales measuring confidence in the subject, usefulness of the subject, motivation for further mathematics study, and mathematics enjoyment. On the other hand, Kargar and his colleagues (2010) study used three subscales namely, Self confidence scale, Value-Enjoyment scale, and Motivation scale and the present study used four subscales measuring students' perception of their general attitude towards maths and success in mathematics, parents' attitude to maths and child's maths study, usefulness of mathematics, and parents' perception of their own attitude to maths and child's maths study.

There is a paucity of research studies investigating the influence of parental involvement on mathematics anxiety and attitude towards mathematics. In a recent study investigating whether mathematics anxiety serves as a mediator in the relationship between parental involvement and mathematics achievement Vukovic, Roberts, and Wright (2013) found that parental involvement reduced mathematics anxiety in influencing mathematics achievement among second grade students in the United States. The present study found a non-significant association between parental involvement and mathematics anxiety involving secondary school students. The differences in the findings could be due to cultural differences in which parents were involved, or age of the participants. The participants in Vukovic, Robert, and Wright's (2013) study were second graders of an ethnic minority and from a low-income background living in the United States, whereas the present study involved Year 9 and Year 11 students from a middle class socio-economic group in India. The parents in the Vukovic, Robert, and Wright's (2013) study were directly involved in the mathematics learning of their child. In the current study the parents were not directly involved in their child's learning in mathematics, but acted as providers. The association between parental involvement and attitude towards mathematics was significant and positive in this study. These findings are discussed in detail in the following sections.

6.2.1 Research Question: 1 How does parental involvement in learning influence the mathematics achievement of secondary school students in India?

The current study investigated the association between parental involvement and mathematics achievement and found no significant relationship between the variables.

This result supports the findings of, for example, El Nokali, Bachman, and Votruba-Drzal (2010), who found that parental involvement was not significantly related to mathematics achievement among elementary school students in the United States. In their study parental involvement dimensions included were parental encouragement of a child's education, parental investment (value placed on education by parents), and parents' educational attitudes (parents' educational goals for their child). Hemalatha and Sabitha (2009) also found that parental involvement had no significant relationship with the academic achievement of Year 9 students in Kerala, India, the same region as was the location of the current study.

Research studies have also reported the positive influence of parental involvement in the mathematics achievement of students in general. For example, studies have found that parental involvement in the form of parental encouragement to pursue higher education, communication between parent and child influences mathematics achievement of high school students (e.g., Jeynes, 2005; Catsambis, 2001).

The construct was defined in Hemalatha and Sabitha's (2009) study as the amount of participation of parents' in their child's study and other activities. The present study produced a similar finding even though it used a broader conceptualisation of parental involvement in terms of parental involvement as parental participation in school-related activities (such as monitoring of home study and attending parent-teacher interviews), parental encouragement of academic success, and parental expectations of educational attainment and parenting style.

Generally, involvement of parents in the education of their children in terms of specific behaviours decreases as the students progress through their schooling (Griffith, 1998; Stevenson & Baker, 1987). The non-significant relationship between parental involvement and mathematics achievement in this study may have been because the parents were not directly involved in the mathematics learning of these students who were in Year 9 or Year 11, but rather acted as resource providers and motivators. In particular, the qualitative results from the parent data in this study indicated that parents were indirectly helping the students in their mathematics education by arranging extra tutorials, buying text books, and encouraging them to score better.

6.2.2 Research Question: 2 How does attitude towards mathematics influence mathematics achievement of secondary school students in India?

The effect of attitude towards mathematics on the mathematics achievement of students was investigated in this study. The study found a non-significant relationship between attitude towards mathematics and mathematics achievement. This result is in agreement with the findings of Chagwiza, Mutambara, Tatira, and Nyaumwe (2013) who also found no significant relationship between attitude towards mathematics and achievement in mathematics for secondary school students from three urban schools in Bindura, Zimbabwe. The finding of the current study is, however, contrary to the broad consensus of the literature. For example, K. C. Cheung (1988) found that attitude towards mathematics positively influenced mathematics achievement of Grade 7 students based on the second International Association for the Evaluation of Educational Achievement (IEA) mathematics study, the Second International Mathematics Study (SIMS), data from Hong Kong, showing that the more positive attitude students have for mathematics, the higher will be their mathematics achievement. More recently, in the Trends in International Mathematics and Science Study (TIMSS), it was found that among the Year 8 students in the participating countries, on an average, attitude towards mathematics was found to have a positive influence on mathematics achievement

(Thomson, Hillman, & Wernert, 2012).

In the TIMSS study (Thomson, Hillman, & Wernert, 2012), the construct attitude towards mathematics was conceptualised in terms of students' attitude towards mathematics in general, the value of mathematics for improving lives, and self-confidence in mathematics. Attitude towards mathematics was conceptualised in this study as general attitude towards maths and success in mathematics, and usefulness of mathematics; self confidence in mathematics was not included in the conceptualisation of the construct. In the present study, attitude towards mathematics was measured using four measures, students' perception of their general attitude towards maths and success in mathematics, and their perception of usefulness of mathematics, students' perception of their parents' attitude to maths and their child's maths study, and parents' perception of their own attitude to maths and child's maths study. The inconsistency in the findings, compared with previous studies, could be due to these differences in the conceptualisation and to differences in the measures employed for the assessment of the construct in the studies. The participants in the Trends in International Mathematics and Science Study (TIMSS) study were Year 8 students, whereas the present study involved Year 9 and Year 11 students. In addition, the current study used students' and parents' self reports to measure the construct, whereas the TIMSS study (Thomson, Hillman, & Wernert, 2012) used only students' reports. In addition, the qualitative results of this study suggest that at least some Indian students are motivated to work hard and achieve highly in mathematics even when they find it difficult. A tendency to work hard even when one's attitude to the subject is negative could result in relatively high achievement.

6.2.3 Research Question: 3 How does mathematics anxiety influence mathematics achievement of secondary school students in India?

The study tested the association between mathematics anxiety and the mathematics achievement of secondary school students and found a non-significant relationship between the variables. This is in contrast to the previously reported research findings. For example, Ma (1999) found a significant, but small negative correlation between mathematics anxiety and achievement in mathematics in his meta-analysis of the studies of mathematics anxiety. The participants in Ma's study were students from Grade 4 to Grade 12 in the United States, Thailand, Australia, Lebanon, Israel, and New Zealand. Among Indian students, researchers have also reported a negative correlation between mathematics anxiety and achievement in mathematics (Karimi & Venkatesan, 2009; Khatoon & Mahmood, 2010), that is higher, the level of anxiety, the lower the achievement.

In a culture like India that emphasises a person's intellectual abilities and assigns positions in society based on academic achievement, it is very common for students to experience stress in academic endeavours (Deb, Chatterjee, & Walsh, 2010; Verma, 1998). Indian parents maintain high expectations about their child's academic performance to get admission to esteemed courses like medicine, engineering or law in prestigious institutions (Deb et al., 2010; Verma, Sharma, & Larson, 2002). Thus the Indian children may feel pressured to live up to their parents' expectations (Liu, 1998) and this might contribute to mathematics anxiety. In India more emphasis is placed on academic achievement than on extra curricular activities (Verma et al., 2002). Consistent with these findings, interview data in this study revealed that parents had high expectations concerning their children's academic achievement and future careers and that the students were willing to fulfil their parent's expectations. Some researchers suggest that certain level of anxiety can act as a motivating factor (H. Z. Ho et al., 2000; J. Lee, 2009). Because academic success is regarded as a necessity in the Indian context, it could be that students in this study, but not in those of Karimi and Venkatesan (2009) and Khatoon and Mahmood (2010), were determined to study well and to prove themselves, and hence achieved highly even though they experienced anxiety.

6.2.4 Research Question: 4 How do parental involvement, attitude towards mathematics and mathematics anxiety interact to influence the mathematics achievement of secondary school students in India?

The present study investigated the relationship between mathematics anxiety, attitude towards mathematics, and parental involvement. The findings revealed a significant positive correlation between mathematics anxiety and attitude towards mathematics, that is higher the anxiety in relation to mathematics, the more positive the attitude towards mathematics. This contradicts the findings of most earlier studies. For example, Durrani and Tariq (2009) found that greater mathematics anxiety was associated with poorer attitude towards mathematics in the context of the development of perceptions of competence in numeracy skills among undergraduate students at the University of Central Lancashire. Kargar et al. (2010) also found a negative correlation between mathematics anxiety and attitude towards mathematics among university students in Malaysia. The participants in Durrani and Tariq's (2009) and Kargar et al.(2010) studies were undergraduate students, whereas the participants of this study were Year 9 and Year 11 students in India.

Durrani and Tariq (2009) in their study measured mathematics anxiety using a mathematics anxiety scale with three subscales namely, maths text anxiety (measuring fear pertaining to preparing for or taking a test in mathematics/numeracy), numerical task anxiety (measuring apprehension relating to execution of numerical operations), and maths course anxiety (measuring stress associated with studying and learning in or for a maths class. They used an attitude towards mathematics scale with four subscales measuring, personal confidence about the subject matter, usefulness of the subject's content, motivation to pursue studies in mathematics, and enjoyment of mathematics/numeracy to evaluate the variable attitude towards mathematics (Durrani & Tariq, 2009). Kargar et al. (2010) measured mathematics anxiety using Mathematics Anxiety Rating Scale (MARS-R) with two subscales; Learning Math Anxiety scale and Math Evaluation Anxiety scale. The researchers assessed attitude towards mathematics using Mathematics Attitudes Questionnaire (MAQ) with the subscales, Self confidence scale, Value-Enjoyment scale, and Motivation scale (Kargar et al., 2010). In the current study mathematics anxiety was measured by students' perception of their anxiety, their confidence in learning mathematics, and their motivation, and parents' perception of their own mathematics anxiety. Attitude towards mathematics was measured in the current study in terms of students' perception of their general attitude towards maths and success in mathematics, and usefulness of mathematics, students' perception of their parents' attitude to maths and child's maths study, and parents' perception of their own attitude to maths and child's maths study.

In summary the key differences in the constructs are that the current study used both students' and parents' self reports in measuring the constructs, whereas the Durrani and Tariq's (2009) and Kargar et al.(2010) studies used only students' self reports. In this study the measures confidence in mathematics and motivation in mathematics learning were used to assess mathematics anxiety, but the two measures were included in the Durrani and Tariq's (2009) and Kargar et al.(2010) studies to evaluate the construct attitudes to mathematics. The measure enjoyment in mathematics was used to assess attitudes to mathematics by Kargar et al. and Durrani and Tariq, not in the current one. In addition, as mentioned earlier, Year 9 and Year 11 students participated in this study, whereas undergraduate students were the participants in Durrani and Tariq's (2009) and Kargar et al. (2010) studies. These differences in the constructs and their measurement, and the sample could have contributed to the inconsistent results across the studies.

Not much work has been done to understand the relationship between mathematics anxiety and parental involvement. This study found that the relationship between mathematics anxiety and parental involvement was not significant. The finding of this study is not consistent with the general consensus of the literature. For example, this finding is not in agreement with the results of Vukovic, Roberts, and Wright (2013). They studied the role of mathematics anxiety in the relationship between parental involvement and mathematics achievement among second grade students and their parents in the United States. The researchers found that parental involvement reduces mathematics anxiety of the participants particularly for more difficult mathematics topics. The participants in Vukovic, Robert, and Wright's (2013) study were of an ethnic minority and from a low-income background living in north-eastern United States. The participants in this study were students in Year 9 and Year 11 and their parents in India from a middle class socio-economic group, so the disparity is perhaps unsurprising. In addition, Vukovic, Robert, and Wright (2013) measured mathematics anxiety using items tapping worry and physical symptoms in relation to anxiety. Parental involvement was measured in terms of parent's involvement in child's education, home support and expectations, and valence (beliefs) toward school. In the present study mathematics anxiety was measured by students' perception of their anxiety, their confidence in learning mathematics, and their motivation, and parents' perception of their mathematics anxiety. Parental involvement was measured in the current study in terms of parental participation in school-related activities (such as monitoring of home study and attending parent-teacher interviews), parental encouragement of academic success, and parental expectations of educational attainment and parenting style. These differences in the measurement of the constructs and the sample may have contributed to the different results.

In the Indian scenario education is considered a responsibility, a duty to the family, a way of gaining social mobility and acceptance, and a form of recognition (Faria, 2001). Higher education is associated with high social status, financial gain, and improved career opportunities (Dhesi, 2001). Students are, therefore, under pressure from family,teachers and society to excel in their studies. They also face strong competition from their peers to achieve more in their studies. High achievement in mathematics is considered important for further education and career opportunities. All these factors could contribute to anxiety in mathematics among the students. The influence of parental involvement on mathematics anxiety may be insignificant in comparison to other factors described here and could be the reason for the non-significant relationship between parental involvement and mathematics anxiety.

The study, however, showed a significant positive relationship between attitude towards mathematics and parental involvement. In the Indian cultural context, parents typically have high expectations for their children's educational achievement. They convey their expectations to their children through regular reinforcement of academic success and hard work. The parents in this study were found to not be directly involved in the mathematics learning of their children. Rather they provided extra tutorials in mathematics, and bought books and other materials for their study. Above all, the parents constantly communicated their expectations to their children and monitored their educational progress. Even though the students are constantly under pressure to excel in their studies and hence likely to have been anxious, the constant communication of parental expectations and academic excellence could contribute to a positive attitude to mathematics in the students by promoting the idea that high achievement in mathematics is important for further educational opportunities. This could be the reason for the significant association among parental involvement and attitude towards mathematics in this study.

6.2.5 Research Question: 5 Are there gender differences in relation to any of these variables and/or their relationships?

No gender difference was found in relation to attitude towards mathematics among the participants of the study. This finding was in agreement with the results of previous research studies. For example, Farooq and Shah (2008) found no significant gender difference in attitude towards mathematics among Year 10 students in Pakistan. Similarly, Mohammed and Waheed (2011), reported that boys and girls at the secondary level in Maldives (an island nation 400 km south-west of India), did not significantly differ in their attitude towards mathematics. The cultural context, in terms of valuing of education and the system of education, in India, Pakistan, and Maldives is comparatively similar. In addition, Tapia (2004) reported no significant difference in attitudes towards mathematics among the male and female undergraduate students in her study in the United States. Nicolaidou and Philippou (2003), in Cyprus, also found no significant difference in attitude towards mathematics between fifth grade boys and girls.

On the other hand, in the recent TIMSS, Year 8 Australian males were found to have more positive attitude towards mathematics than their female counterparts (Thomson, Hillman, & Wernert, 2012). The TIMSS measured students' attitude towards mathematics in general, their perceptions of the value of mathematics for improving lives, and their self-confidence in mathematics. The present study used the measures, students' perception of general attitude towards maths and success in maths, and usefulness of mathematics, students' perception of their parents attitude to maths and their child's maths study, and parents' perception of their own attitudes to maths and child's maths study, to assess attitude towards mathematics among the participants. Self-confidence was not included as a measure to evaluate attitude towards mathematics, and students' and parents' self reports were used to measure the construct in the present study. These differences in the conceptualisation and measurement of the construct could have contributed to the disagreement in the findings. In addition, the differing cultural contexts of India and Australia could have added to the inconsistent findings.

No significant gender difference in mathematics anxiety was observed among the participants in this study. This finding is in agreement with the results of some other studies that have explored gender difference in mathematics anxiety. For example, Chinn (2009) found no significant difference in mathematics anxiety among secondary school students in England and Birgin, Baloglu, Cathoglu, and Gurbuz (2010) found no gender difference in mathematics anxiety among students from Grade 6 to Grade 8 in Turkey. Researchers are not in agreement regarding gender difference in mathematics anxiety among students. For example, some researchers have reported that girls have more mathematics anxiety than boys (e.g., Hopko, 2003; Pajares & Miller, 1994; Tapia, 2004; OECD, 2014), others have reported that boys have more anxiety in mathematics than girls (Deb et al., 2010). Different findings are likely due to the differing conceptualisations and measures of the construct.

For example, the finding of this study is inconsistent with that of Woodard (2004), who found girls had more mathematics anxiety than boys among post-secondary developmental mathematics students in the United States (Developmental or remedial mathematics courses have been offered to students who didn't meet the enrolment criteria to tertiary mathematics courses)(Woodard, 2004). The Mathematics Anxiety Rating Scale (MARS) developed by Richardson and Suinn (F. Richardson & Suinn, 1972) was used to measure the mathematics anxiety of students in Woodard's (2004) study. Richardson and Suinn's (1972) Mathematics Anxiety Rating Scale (MARS) was designed to measure participants' anxious responses to mathematics in academic and everyday life situations. In the current study mathematics anxiety focussed on mathematics learning contexts and was measured by students' perception of their anxiety, their confidence in learning mathematics, and their motivation, and parents' perception of their mathematics anxiety. Even though the participants in the current study and Woodard (2004) study were secondary school students aged above 13 years, the inconsistent findings could be because of the differences in the measurement of the construct.

This study also failed to find any gender difference in parental involvement among the participants of the study. This finding is consistent with the results of Olatoye and Ogunkola's (2008) study who found that no gender difference existed in parental involvement for junior secondary school students in Ogun State in Nigeria (Olatoye & Ogunkola, 2008). The result of the current study is however, inconsistent with other studies that have found significant gender differences in parental involvement among the participants. For example, some researchers have found that parents were more involved with their daughters than with sons in school related matters (e.g., Carter & Wojtkiewicz, 2000; P. Keith & Lichtman, 1994). Both these studies used data from the National Educational Longitudinal Study of 1988 (NELS:88) data base. However, the participants in Carter and Wojtkiewicz's (2000) study were Grade 8 students in the United States, and Keith and Lichtman's (1994) study included 8^{th} grade Mexican-American students, rather than Years 9 and 11 Indian students. Others have found more parental involvement with sons in terms of academic supervision, higher expectations,and school activities (e.g., Schoolland, 1990; Verma & Gupta, 1990). Both of these studies were conducted among Asian students; Schoolland's (1990) study included Japanese high school students, whereas participants in Verma and Gupta's (1990) study were high school students in India. The recent economic and social changes in India have brought about more equal educational opportunities for women. This has resulted in an increase in the number of educated and working women in the present generation and thus parents becoming more equally involved in the education of sons and daughters. This trend is especially so in the state which was the site of the present study. This could have contributed to the absence of any gender difference in parental involvement among the participants.

Consistent with the findings of Venkatsh and Karimi (2010), who found no gender difference in mathematics achievement among secondary school students from three states Tamilnadu, Kerala, and Karnataka in India, this study also found that the boys and girls did not differ significantly in their achievement in mathematics. Other Indian studies have also failed to find any significant gender difference in mathematics achievement. For example, Choudhury and Das (2012) also reported the absence of a significant gender difference in mathematics achievement among secondary school students in Assam, India. Elsewhere, Mullis et al. (2000) found no significant gender difference among Turkish students in their mathematics achievement based on the Trends in International Mathematics and Science Study (TIMSS) data. Contrary to these findings, significant gender differences were observed among Year 8 students in mathematics achievement in some countries in the most recent TIMSS (Mullis, Martin, Foy, & Arora, 2012). For example, boys significantly outperformed girls in mathematics in New Zealand, Korea, Lebanon, Italy and Chile. On the other hand, Year 8 girls performance in mathematics was significantly higher than boys in Singapore, Malaysia, Jordan, Indonesia, Bahrain,and Armenia. It appears that in some countries that participate in TIMSS, gender differences in mathematics achievement have changed over time. Because India has not been a participant in the TIMSS studies, it is not possible to say whether this is also the case in India.

6.2.6 Research Question: 6 Gender differences in the inter-relationship among the variables

Consideration of whether the relationship of mathematics anxiety, attitude towards mathematics, and parental involvement with mathematics achievement differed for the boys and the girls, revealed no significant gender difference in any of the relationships for the participants in this study.

The non-significant gender difference in the relationship between mathematics anxiety and mathematics achievement in this study, is consistent with the findings of the meta analysis of the studies of mathematics anxiety by Ma (1999) among Grades 4 to Grade 12 students in the United States, Thailand, Australia, Lebanon, Israel, and New Zealand. The current study found no significant gender difference in the relationship between attitude towards mathematics and mathematics achievement, which is in agreement with the meta analysis of Ma and Kishor (1997). The present study also found no significant difference in the parental involvement and mathematics achievement relationship among secondary school students, which is in agreement with the findings of other research studies. For example, T. Z. Keith et al. (1998), in a longitudinal study, found no significant differences in the relationships between the variables among high school students in US.

There appears to have been little research on the influence of gender on the inter-relationship between mathematics anxiety and attitude towards mathematics, mathematics anxiety and parental involvement, and attitude towards mathematics and parental involvement. The present study found no significant difference for boys and girls in the relationship between mathematics anxiety and attitude towards mathematics. Similarly, no significant gender difference was observed in the relationship between mathematics anxiety and parental involvement in the study. In addition, the study failed to find any significant gender difference in the association between attitude towards mathematics and parental involvement.

6.3 Limitations of the study

The findings of the study need to be interpreted taking its limitations into consideration. Firstly, the sample was restricted to students in Year 9 and Year 11 and their parents, from a single urban private school. Secondly, causality in the relationship between the variables cannot be established because of the cross-sectional nature of the study, but it is possible to understand the correlational relationships among the variables. A more comprehensive measure of mathematics achievement may have given stronger findings. In this study only a single measure of achievement in mathematics was used. For example, teacher reports of students' mathematics achievement could have been included as a second measure of mathematics achievement thereby enhancing the validity of the findings. The student questionnaire and achievement test in mathematics were administered on the same day, one week before the second term examinations. It is possible that the students' responses may have been influenced by stress because of the term examinations, rather than anxiety in mathematics. In spite of these limitations the study established a foundation for further research. Possible directions for this research are described in the next section.

6.4 Recommendations for further research

Recommendations for further research arising from the study include investigating the relationship between the variables over a wider geographical area within India, and including both public and private schools, and also schools in both urban and rural areas. In particular,it is possible that there may be differences in the parental involvement practices among students from urban and rural areas and there may be differences between states due to differing educational policies and histories, as well as differing cultural contexts. A longitudinal study of the variables and their long term impact on mathematics achievement among secondary school students would help in understanding casual relationships among the variables. It would also be interesting to replicate the study with different measuring instruments than those used in the present study.

The study could be replicated with the inclusion of Year 10 and Year 12 students to investigate the relationship among the variables. This could be of interest because in Kerala, students have to appear for their Secondary Examination in Grade 10 to secure admission to their preferred academic course for senior secondary school. In Grade 12 they have to sit the Higher Secondary Examination to get admission to prestigious courses like medicine, engineering, and law. Competition is fierce because performance in the Secondary Examination determines admission to prestigious self-financing higher secondary schools (run by individuals, trusts or churches) and performance in Higher Secondary Examination determines admission to prestigious courses in high quality universities. One might therefore expect more parental participation in their children's studies in Years 10 and 12 compared with Years 9 and 11. The high stake examination context of Years 10 and 12 could particularly effect how parental involvement relates to mathematics achievement of these students.

Further, research studies in western contexts have shown that factors such as teacher-student relationship (Hamre & Pianta, 2001; Hughes & Kwok, 2006), teacher competency (B. Nye, Konstantopoulos, & Hedges, 2004; Sanders & Rivers, 1996), peer support (Hill & Rowe, 1998), and the socio-economic status and educational level of parents (Demir, Kilic, & Unal, 2010; Guo & Harris, 2000; Starkey & Klein, 2000) influence academic achievement of students. It would be, therefore, interesting to investigate the influence of these factors on mathematics achievement of secondary school students in India and their interaction with the variables considered in this study. Further exploration of a comparative study between India and for example, Australia may help in understanding the role of cultural differences in the relationship among the variables.

6.5 Conclusion

The study investigated how the variables mathematics anxiety, attitude towards mathematics, and parental involvement influenced mathematics achievement of secondary school students in India. Previous research has demonstrated the effect of these variables on mathematics achievement of students with significant as well as non-significant results. This study found a non-significant relationship between mathematics anxiety and mathematics achievement. The relationships among attitude towards mathematics and mathematics achievement, and between parental involvement and mathematics achievement were also not significant. The study found a significant, positive relationship between parental involvement and attitude towards mathematics, and a significant positive correlation between mathematics anxiety and attitude towards mathematics. The findings may help parents to adopt parental involvement practices that could help in developing a more positive attitude towards mathematics. Teachers may use findings of the study to help the students in their mathematics learning. They could adjust their teaching strategies to develop positive attitudes to the learning of mathematics among their students, but both parents and teachers need to be mindful that enhancing positive attitude to mathematics conceptualised as beliefs in its usefulness and importance may be associated with greater mathematics anxiety. Care needs to be exercised in keeping the mathematics anxiety level of the students to a comfortable point that motivates them.

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Appendix

Appendix A: Student Questionnaire

UNIVERSITY OF TASMANIA

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

STUDENT QUESTIONNAIRE

Thank you for taking part in the study

This questionnaire is designed to understand the influence of parental involvement, students' mathematics anxiety and attitude towards mathematics on their mathematics achievement. This is a measure of personal belief; obviously there are no right or wrong answers. Be sure not to omit any items. All your answers will be kept confidential.

DIRECTIONS: On the following pages you will find several statements that you may or may not agree with. You are asked to determine how strongly you feel about the statement from strongly disagree to strongly agree. Please express the extent of your agreement with each statement by placing a tick mark (✓) under the column that best describes your answer.

For example:

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Ex	I don't like doing word problems in mathematics		✓			

1. If you want to change your answer, please cross out the tick mark and mark another column.

2. 'Parent' is defined for this study as biological parents or one who nurtures and cares for the child.

3. Please provide the following information:

Demographic Information

Age:

Gender (circle one): Male Female

Grade (circle one): 9 10 11 12

Student Questionnaire [1] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I like learning maths more than any other subject					
2	Generally I feel secure while attempting maths					
3	My parents encourage me to score well in maths					
4	Mathematics doesn't scare me at all					
5	My parents think that mathematics is one of the most important subjects to study					
6	I like maths puzzles					
7	I'll need mathematics for my future career					
8	My parents feel that in a well-run home the children should have their way in the family as often as the parents do.					
9	I do as little maths as possible when I get the choice					

[1]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [2] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
10	My parents do not direct the behaviours, activities and desires of the children in the family.					
11	I am sure I could do advanced mathematics					
12	My parents would get upset if I tried to disagree with them					
13	I never get nervous during a maths test					
14	My parents think I'll need mathematics for what I want to do after I finish secondary schooling					
15	Mathematics is interesting and enjoyable to me					
16	My parents check my maths homework regularly					

[2]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [3] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
17	My parents feel that it is for my own good if I am forced to conform to what they think is right, even if I do not agree with them					
18	Studying mathematics will help me to earn a living					
19	Maths is the easiest subject at school					
20	I think I can handle difficult mathematics					
21	Once a family policy has been established, my parents will discuss the reasoning behind it with the children in the family.					
22	I have been at ease in maths classes					
23	My parents think that I have to do well in mathematics to do advanced courses in university					

[3]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [4] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
24	When I get a maths problem which I can't solve immediately, I will stick with it until I have the solution					
25	My parents help me with difficult problems in maths					
26	I will use mathematics in many ways as an adult					
27	My parents allow me to decide most things for myself without much direction from them.					
28	Having good mathematics skills is important for a well rounded education					
29	My parents ask me about my assessment results in maths					
30	Mathematics is a worthwhile and necessary subject					

[4]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [5] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
31	My parents think I am the kind of person who could do well in mathematics					
32	I have been at ease during maths tests					
33	My parents usually take the children's opinions into consideration when making family decisions, but would not decide something simply because the children want it.					
34	I am sure I can get good grades in maths					
35	My parents have always felt that what children need is, to be free to make up their own minds and to do what they want to do, even if it does not agree with what their parents might want.					

[5]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [6] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
36	When a question is left unanswered in maths class, I continue to think about it afterwards					
37	I do not enjoy learning maths					
38	My parents do not allow me to question any decision they make					
39	I'll need a firm mastery of mathematics for my future career					
40	It wouldn't bother me at all to take advanced maths courses					
41	My parents have always been interested in my progress in mathematics					
42	Once I start trying to work on a maths puzzle, I find it hard to stop					
43	My parents try to provide a good learning environment at home to study mathematics					

[6]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [7] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
36	When a question is left unanswered in maths class, I continue to think about it afterwards					
44	I have a lot of self-confidence when it comes to mathematics learning					
45	It would make me happy to be recognised as an excellent student in mathematics					
46	I don't think I can do advanced maths					
47	Mathematics will not be important to me in future career					
48	Mathematics usually makes me feel uncomfortable and nervous					
49	My parents think I need to know only a minimum of mathematics for the future					

[7]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [8] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
36	When a question is left unanswered in maths class, I continue to think about it afterwards					
49	My parents think I need to know only a minimum of mathematics for the future					
50	The challenge of mathematics problems does not appeal to me					
51	My parents encourage me to work hard on maths problems even though the problems are difficult					
52	I'm not the type of person to do well in mathematics					
53	I'd proud to be the outstanding student in mathematics					
54	My parents direct the activities and decisions of the children in the family through reasoning					

[8]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [9] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
55	I see mathematics as a subject I rarely use in my future					
56	Maths has been my worst subject					
57	I usually get a sinking feeling when I try to do maths					
58	My parents think advanced maths is a waste of time for me					
59	I don't understand how some people can spend so much time on maths and seem to enjoy it					
60	My parents direct the activities and decisions of the children in the family through discipline					
61	My parents feel that wise parents should teach their children early who is the boss of the family.					

[9]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [10] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
62	Being first in a mathematics competition would make me pleased					
63	My parents frequently monitor the time I spend on mathematics at home					
64	Mathematics is of no relevance to my life					
65	My mind goes blank and I am unable to think clearly while doing a maths test					
66	As long as I have passed, my parents don't care about my progress in mathematics					
67	Figuring out mathematics problems does not appeal to me					
68	Taking mathematics is a waste of time					

[10]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [11] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
62	Being first in a mathematics competition would make me pleased					
63	My parents frequently monitor the time I spend on mathematics at home					
64	Mathematics is of no relevance to my life					
65	My mind goes blank and I am unable to think clearly while doing a maths test					
66	As long as I have passed, my parents don't care about my progress in mathematics					
67	Figuring out mathematics problems does not appeal to me					
68	Taking mathematics is a waste of time					

[11] Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [12] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
69	I know what my parents expect of me in the family, but I also feel free to discuss those expectations with my parents when I feel that they are unreasonable.					
70	If I had good grades in maths, I would try to hide it					
71	For some reason even though I study hard, mathematics is difficult for me					
72	My parents monitor the time I spend on watching TV					
73	I worry about my ability to solve maths problems					
74	My parents hate doing maths					
75	I do as little work in mathematics as possible					
76	My parents expect me to study advanced maths courses in university					

[12]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [13] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
77	My parents seldom give me expectations and guidelines for my behaviour.					
78	I don't like people to think I'm smart in maths					
79	I am not good at maths					
80	My parents contact my teachers regularly to discuss my performance in maths					
81	Mathematics makes me feel confused					
82	My parents have never shown any interest in whether I take more maths courses or not					
83	I would rather have someone give me the solution to a difficult maths problem than have to work it out for myself					

[13] Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Student Questionnaire [14] - Page 1 of 8

Instructions: Please place a tick mark (✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
84	I expect to have little use for mathematics when I get out of school					
85	My parents give me clear directions for my behaviours and activities, but they will also understand when I disagree with them.					

(Note: End of questionnaire, please go to the next page)

[14]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Please indicate your willingness to participate in an interview, if selected. The interview will be based on any or all of the factors considered in the questionnaire.

I agree to participate in the interview, if selected Yes ☐ No ☐

If yes, please provide your email or postal address to which the interview consent form will be sent.

Email ID:

Telephone Number:

Thank You

Appendix B: Details of changed items in student questionnaire

Details of reworded and reverse coded items in the student questionnaire

Items No:	Original Items	Questionnaire items (reworded or not)	Reverse coded or not (Yes/No)
sattitude scale			
1	I do as little maths as possible when I get the choice	I do little maths as possible when I get the choice	Yes
2	I really do not enjoy learning maths	I do not enjoy learning maths (reworded)	Yes
3	I'd proud to be the outstanding student in math	I'd proud to be the outstanding student in mathematics (reworded)	No
4	If I had good grades in math, I would try to hide it	If I had good grades in maths, I would try to hide it (reworded)	Yes
5	I don't like people to think I'm smart in math	I don't like people to think I'm smart in maths (reworded)	Yes
sconfidence scale			
6	Generally I feel secure about attempting mathematics	Generally I feel secure while attempting maths (reworded)	No
7	I think I could handle more difficult mathematics	I think I can handle difficult mathematics (reworded)	No
8	I am sure I could do advanced work in mathematics	I am sure I could do advanced mathematics (reworded)	No
9	I can get good grades in mathematics	I am sure I can get good grades in maths (reworded)	No

10	I have a lot of self-confidence when it comes to math	I have a lot of self-confidence when it comes to mathematics learning (reworded)	No
11	I don't think I could do advanced mathematics	I don't think I can do advanced maths (reworded)	Yes
12	I'm not the type to do well in math	I'm not the type of person to do well in mathematics (reworded)	Yes
13	Math has been my worst subject	Maths has been my worst subject (reworded)	Yes
14	For some reason even though I study , math seems unusually hard for me	For some reason even though I study hard, mathematics is difficult for me (reworded)	Yes
15	I am no good at maths	I am not good at maths (reworded)	Yes
	susefulness scale		
16	I'll need mathematics for my future work	I'll need mathematics for my future career (reworded)	No
17	Knowing mathematics will help me earn a living	Studying mathematics will help me to earn a living (reworded)	No
18	I'll need a firm mastery of mathematics for my future work	I'll need a firm mastery of mathematics for my future career (reworded)	No
19	Mathematics is of no relevance to my life	Mathematics is of no relevance to my life	Yes
20	I see mathematics as a subject I rarely use in daily life as an adult	I see mathematics as a subject I rarely use in my future (reworded)	Yes
21	Mathematics will not be important to me in my life's work	Mathematics will not be important to me in future career (reworded)	Yes
22	Taking mathematics is a waste of time	Taking mathematics is a waste of time	Yes

sanxiety scale

Items No:	Original Items	Questionnaire items (reworded or not)	Reverse coded or not (Yes/No)
23	I expect to have little use for mathematics when I get out of school	I expect to have little use for mathematics when I get out of school	Yes
24	Math doesn't scare me at all	Mathematics doesn't scare me at all (reworded)	No
25	I almost have never got nervous during a math test	I never get nervous during a maths test (reworded)	No
26	I usually have been at ease in math classes	I have been at ease in maths classes (reworded)	No
27	I usually have been at ease during math tests	I have been at ease during maths tests (reworded)	No
28	It wouldn't bother me at all to take more math courses	I wouldn't bother me at all to take advanced maths courses (reworded)	No
29	Mathematics usually makes me feel uncomfortable and nervous	Mathematics usually makes me feel uncomfortable and nervous	Yes
30	I get a sinking feeling when I think of trying math problems	I usually get a sinking feeling when I try to do maths (reworded)	Yes
31	My mind goes blank and I am unable to think clearly when working mathematics	My mind goes blank and I am unable to think clearly while doing a maths test (reworded)	Yes
32	I worry about my ability to maths problems	I worry about my ability to maths problems	Yes
33	Mathematics makes me feel uneasy and confused	Mathematics makes me feel confused (reworded)	Yes

sparentattitude scale

Items No:	Original Items	Questionnaire items (reworded or not)	Reverse coded or not (Yes/No)
34	My father/mother thinks that mathematics is one of the most important subjects I have studied	My parents think that mathematics is one of the most important subjects to study (reworded)	No
35	My mother thinks that I'll need mathematics for what I want to do after I graduate from high school	My parents think I'll need mathematics for what I want to do after I finish secondary schooling (reworded)	No
36	My father/mother thinks I'm the kind of person who could do well in mathematics	My parents think I'm the kind of person who could do well in mathematics (reworded)	No
37	My father/mother has always been in interested in my progress in mathematics	My parents has always been interested in my progress in mathematics (reworded)	No
38	My father/mother thinks I need to know just a minimum amount of math	My parents think I need to know only a minimum of mathematics for the future (reworded)	Yes
39	My father/mother thinks advanced math is a waste time for me	My parents think advanced maths is a waste of time (reworded)	Yes
40	As long as I have passed, my father/mother hasn't cared how I have done in math	As long as I have passed, my parents don't care about my progress in mathematics (reworded)	Yes

sparentattitude scale			
Items No:	Original Items	Questionnaire items (reworded or not)	Reverse coded or not (Yes/No)
41	My father /mother hates to do math	My parents hate doing maths (reworded)	Yes
42	My father/mother has shown no interest in whether I take more math courses	My parents have never shown any interest in whether I take more maths courses or not (reworded)	Yes

Appendix C: Parent Questionnaire

UNIVERSITY OF TASMANIA

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

PARENT QUESTIONNAIRE

Thank you for taking part in the study

This questionnaire is designed to understand the influence of parental involvement, students' mathematics anxiety and attitude towards mathematics on their mathematics achievement. This is a measure of personal belief; obviously there are no right or wrong answers. Be sure not to omit any items. All your answers will be kept confidential.

DIRECTIONS

1. On the following pages you will find several statements that you may or may not agree with. You are asked to determine how strongly you feel about the statement from strongly disagree to strongly agree. Please express the extent of your agreement with each statement by placing a tick mark (✓) under the column that best describes your answer.

   For example:

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
Ex	I don't like doing word problems in mathematics		✓			

2. If you want to change your answer, please cross out the tick mark and mark another column.

3. 'Parent' is defined for this study as biological parents or one who nurtures and cares for the child.

4. Please provide the following information:

Demographic Information

Gender (circle one): Male Female

Relationship to the child:

Grade level of the child:

Parent Questionnaire[15] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
1	I think that mathematics is one of the most important subjects to study					
2	I am not concerned whether my child takes more maths courses in future					
3	I try to provide my child with a good learning environment at home to study mathematics					
4	As a student I was never nervous during a maths test					
5	I direct the activities and decisions of the children in the family through reasoning and discipline.					
6	I feel that in a well- run family the children should have their way in the family as often as the parents do.					

[15]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[16] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
7	I worry about my ability to solve maths problems					
8	I think that my child will need good understanding in mathematics for what he/ she wants to do after finishing secondary schooling					
9	I hate to do mathematics					
10	I encourage my child to achieve high marks in mathematics					
11	I encourage my child to work hard on maths problems even when the problems are difficult					
12	As a student, I usually have been at ease in maths classes					

[16]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[17] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
13	I will always make clear to my child what is expected of him/ her in the family, but I also will give him/ her freedom to discuss those expectations with me when they feel that those expectations were unreasonable.					
14	Even if my child did not agree with me, I feel that it was for their own good if they were forced to conform to what I thought was right.					
15	I think that my child has to do well in mathematics to do advanced courses in university					
16	I am not concerned with the progress of my child in mathematics					

[17]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[18] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
17	I think that my child needs only a pass in maths					
18	I frequently monitor the time my child spends on mathematics at home					
19	As a student, I usually have been at ease during maths tests					
20	I seldom give my child expectations and guidelines for his/her behaviour.					
21	Once a family policy has been established, I usually discuss the reasoning behind the policy with the children in the family.					
22	I think that my child is the kind of person who could do well in mathematics					

[18]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[19] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
23	I try to monitor the time my child spends on watching TV					
24	Mathematics usually makes me feel uncomfortable and nervous					
25	I often tell my child exactly what I want him/her to do and how I expect him/her to do it.					
26	I think that my child needs to know only a minimum maths for the future					
27	I regularly check my child's maths homework					
28	I try to contact my child's teachers regularly to discuss his/her performance in mathematics					
29	I usually get a sinking feeling when I try to do maths					
30	I think that my child will study advanced maths courses in university					

[19]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[20] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
31	I usually give my child clear direction for his/her behaviours and activities, but will try to understand him/her when he/she disagrees with me.					
32	I think that advanced maths is a waste of time for my child					
33	I help my child with difficult problems in mathematics					
34	I expect my child to work hard and do well at school					
35	Mathematics makes me feel confused					
36	I regularly check my child's assessment results in mathematics					

[20]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[21] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
37	I have always felt that what children need is to be free to make up their own minds and to do what they want to do, even if this does not agree with what their parents might want.					
38	I never direct the behaviours, activities and desires of the children in my family.					
39	Mathematics doesn't scare me at all					
40	I try to encourage my child to study well at school					
41	As a student, my mind went blank and I was unable to think clearly while taking a maths test.					
42	I do not allow my child to question the decisions that I make					

[21]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Parent Questionnaire[22] - Page 1 of 5

Instructions: Please place a tick mark(✓) in the column indicating how much you agree or disagree with each of the statement.

	Statement	Strongly disagree	Disagree	Undecided	Agree	Strongly agree
43	I expect my child to get good grades in mathematics at school					
44	I get upset if my child disagrees with me.					
45	I expect my child to go for university studies after finishing school					

(Note: End of questionnaire, please go to the next page)

[22]Source: Mulhern, F., & Rae, G. (1998). Shortened form of the Fennema- Sherman Mathematics Attitude Scales. Educational and Psychological Measurement, 58(2). ©1998 Sage Publications, Inc. & Buri, J. R (1991). Parental Authority Questionnaire, Journal of Personality Assessment, 57(1). ©Lawrence Erlbaum Associates, Inc

Please indicate your willingness to participate in a recorded interview if selected. The audio taped interview will be based on any or all of the factors considered in this questionnaire.

I agree to participate in the interview, if selected Yes ☐ No ☐

If yes, please provide your preferred contact details (email or telephone) to arrange the interview.

Email ID:

Telephone Number:

Thank You

Appendix D: Details of changed items in parent questionnaire

Details of reworded and reverse coded items in the parent questionnaire

panxiety scale			
Items No:	Original Items	Questionnaire items (reworded or not)	Reverse coded or not (Yes/No)
1	Math doesn't scare me at all	Mathematics doesn't scare me at all (reworded)	No
2	I almost never have got nervous during a math test	As a student I was never nervous during a maths test (reworded)	No
3	I usually have been at ease in math classes	As a student, I usually have been at ease in maths classes (reworded)	No
4	I usually have been at ease during math tests	As a student, I usually have been at ease during maths tests (reworded)	No
5	Mathematics usually makes me feel uncomfortable and nervous	Mathematics usually makes me feel uncomfortable and nervous	Yes
6	I get sinking feeling when I think of trying math problems	I usually get a sinking feeling when I try to do maths (reworded)	Yes
7	Mathematics makes me feel uneasy and confused	Mathematics makes me feel confused (reworded)	Yes
8	My mind goes blank and I am unable to think clearly when working mathematics	As a student, my mind went blank and I was unable to think clearly while taking a maths test (reworded)	Yes

Appendix E: Achievement Test

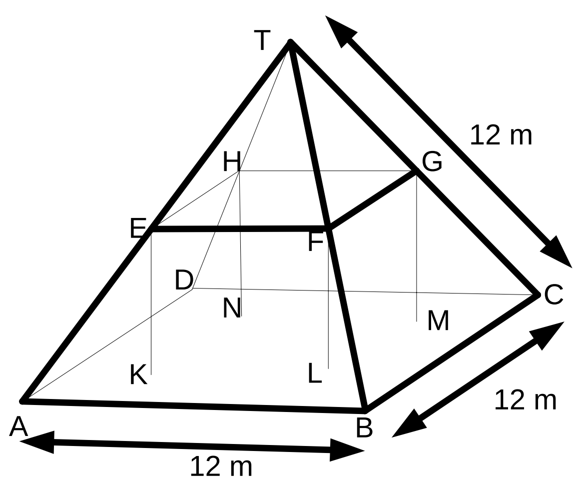
Achievement Test In Mathematics

Time: 40 min

Answer the following questions in the space provided[23]. Show your working out wherever necessary.

Q: 1 Here you see a photograph of a farmhouse with a roof in the shape of a pyramid.

Below is a student's mathematical model of the farmhouse roof with measurements added.



[23]Source: TAKE THE TEST: SAMPLE QUESTIONS FROM OECD'S PISA ASSESSMENTS - ISBN 978-92-64-05080-8 - Ⓒ OECD 2009

The attic floor, ABCD in the model, is a square. The beams that support the roof are the edges of a block (rectangular prism) EFGHKLMN. E is the middle of AT, F is the middle of BT, G is the middle of CT and H is the middle of DT. All the edges of the pyramid in the model have length 12 m.

A. Calculate the area of the attic floor ABCD.

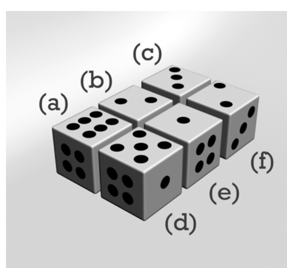
The area of the attic floor ABCD = $\qquad\qquad$ m^2

B. Calculate the length of EF, one of the horizontal edges of the block.

The length of EF = $\qquad\qquad$ m

Q: 2 In this photograph you see six dice, labelled (a) to (f). For all dice there is a rule:

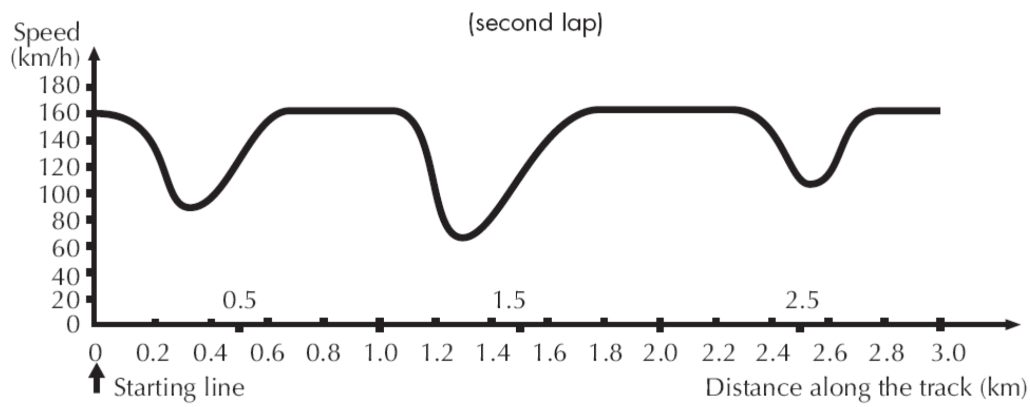
The total number of dots on two opposite faces of each die is always seven. Write in each box the number of dots on the bottom face of the dice corresponding to the photograph.



(a)	(b)	(c)
(d)	(e)	(f)

Q: 3 This graph shows how the speed of a racing car varies along a flat 3 kilometre track during its second lap.

Speed of a racing car along a 3 km track



Now,

A. What is the approximate distance from the starting line to the beginning of the longest section of the track?

1. 0.5 km
2. 1.5 km
3. 2.3 km
4. 2.6 km

B. Where was the lowest speed recorded during the second lap?

1. at the starting line.
2. at about 0.8 km.
3. at about 1.3 km.
4. halfway around the track.

C. What can you say about the speed of the car between the 2.6 km and 2.8 km marks?

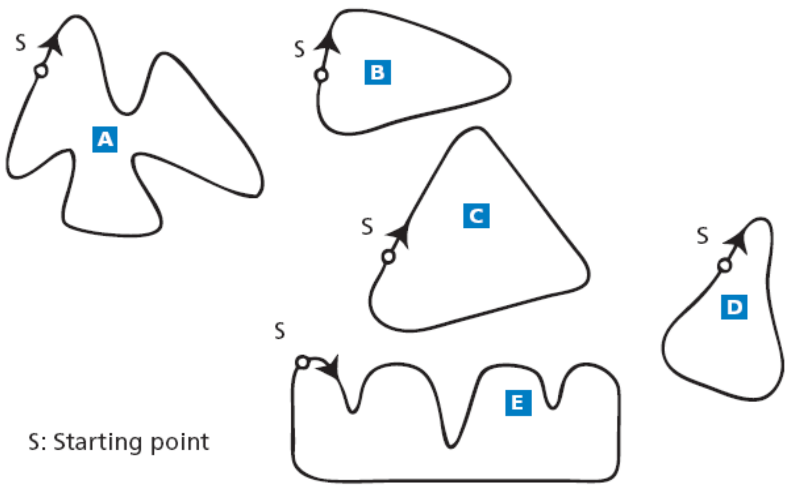
1. The speed of the car remains constant.
2. The speed of the car is increasing.

3. The speed of the car is decreasing.

4. The speed of the car cannot be determined from the graph.

D. Here are pictures of five tracks:

Along which one of these tracks was the car driven to produce the speed graph shown earlier. Circle the letter of the figure to indicate your answer.



Q: 4 Mei- Ling from Singapore was preparing to go to South Africa for 3 months as an exchange student. She needed to change some Singapore dollars (SGD) to South African rand (ZAR).

A. Mei- Leing found out that the exchange rate between Singapore dollars and South African rand was: 1 SGD = 4.2 ZAR. Mei- Ling changed 3000 Singapore dollars into South African rand at this exchange rate. How much money in South African rand did Mei-Ling get?

Answer:

B. On returning to Singapore after 3 months, Mei-Ling had 3900 ZAR left. She changed this back to Singapore dollars, noting that the exchange rate had changed to: 1 SGD = 4.0 ZAR. How much money in Singapore dollars did Mei-Ling get?

Answer:

C. During these 3 months the exchange rate had changed from 4.2 to 4.0 ZAR per SGD. Was it in Mei-Ling's favour that the exchange rate now was 4.0 ZAR instead of 4.2 ZAR, when she changed her South African rand back to Singapore dollars? Give an explanation to support your answer.

Answer:

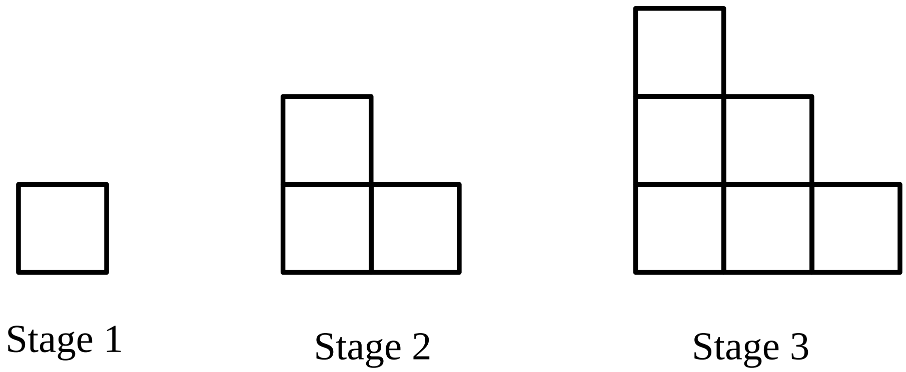
D. In Mei-Lin's school, her science teacher gives tests that are marked out of 100. Mei-Lin has an average of 60 marks on her first four Science tests. On the fifth test she got 80marks. What is the average of Mei-Lin's marks after all five tests?

Average Mark:

Q: 5 Robert builds a step pattern using squares. Here are the stages he follows.

As you can see, he uses one square for Stage 1, three squares for Stage 2 and six for Stage 3. How many squares should he use for the fourth stage?

Answer: ————- squares



Q: 6 A game in a booth at a spring fair involves using a spinner first. Then, if the spinner stops on an even number, the player is allowed to pick a marble from a bag. The spinner and the marbles in the bag are represented in the diagram below.

Prizes are given when a black marble is picked. Sue plays the game once.

How likely it is that Sue will win a prize?

A. Impossible.

B. Not very likely.

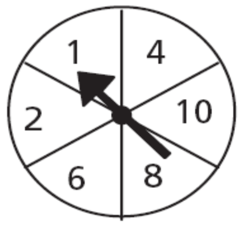
C. About 50% likely.

D. Very likely.

E. Certain

Q: 7 Circle the letter of the figure that best fits the following description.

Triangle PQR is a right triangle with right angle at R. The line RQ is less than the line PR. M is the midpoint of the line PQ and N is the midpoint of the line QR. S is a point inside the triangle. The line MN is greater than the line MS.



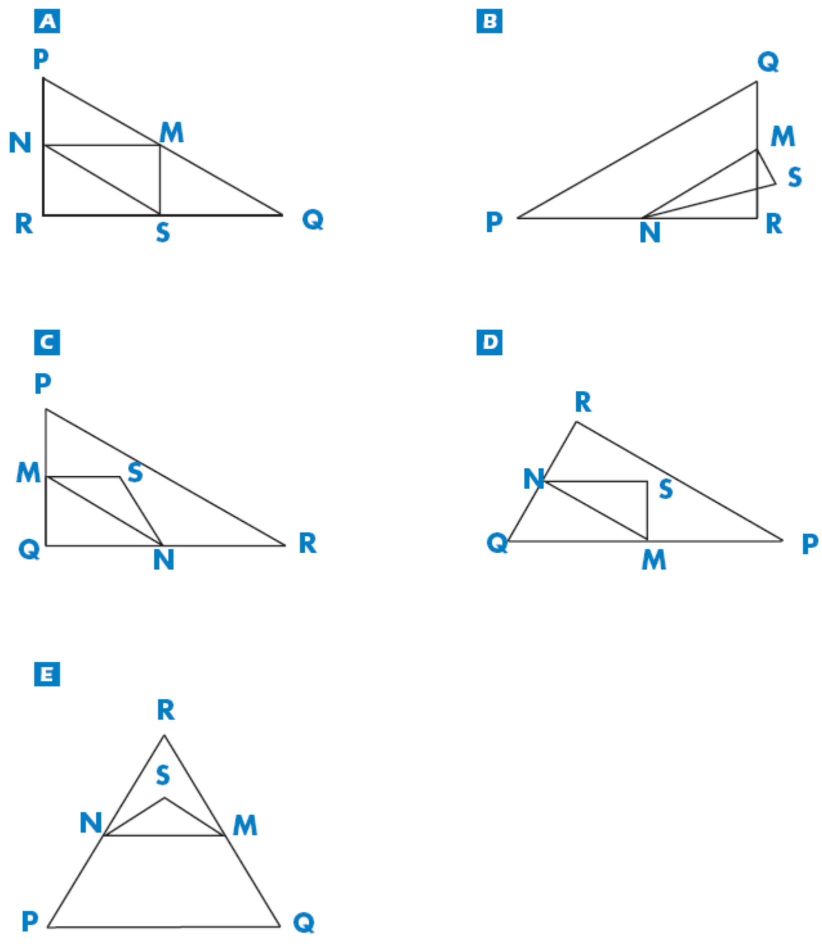
Q: 8 Mark (from Sydney, Australia) and Hans (from Berlin, Germany) often communicate with each other using "chat" on the Internet. They have to log on to the Internet at the same time to be able to chat. To find a suitable time to chat, Mark looked up a chart of world times and found the following:

A. At 7: 00 PM in Sydney, what time is it in Berlin?

Answer:

B. Mark and Hans are not able to chat between 9:00 AM and 4: 30 PM their local time, as they have to go to school. Also, from 11:00 PM till 7:00 AM their local time they won’t be able to chat because they will be sleeping. When would be a good time for Mark and Hans to chat?

Write the local times in the table.



Q: 9 Robert's mother lets him pick one candy from a bag. He can't see the candies. The number of candies of each colour in the bag is shown in the following graph.

What is the probability that Robert will pick a red candy?

A. 10 %

B. 20 %

C. 25 %

D. 50 %

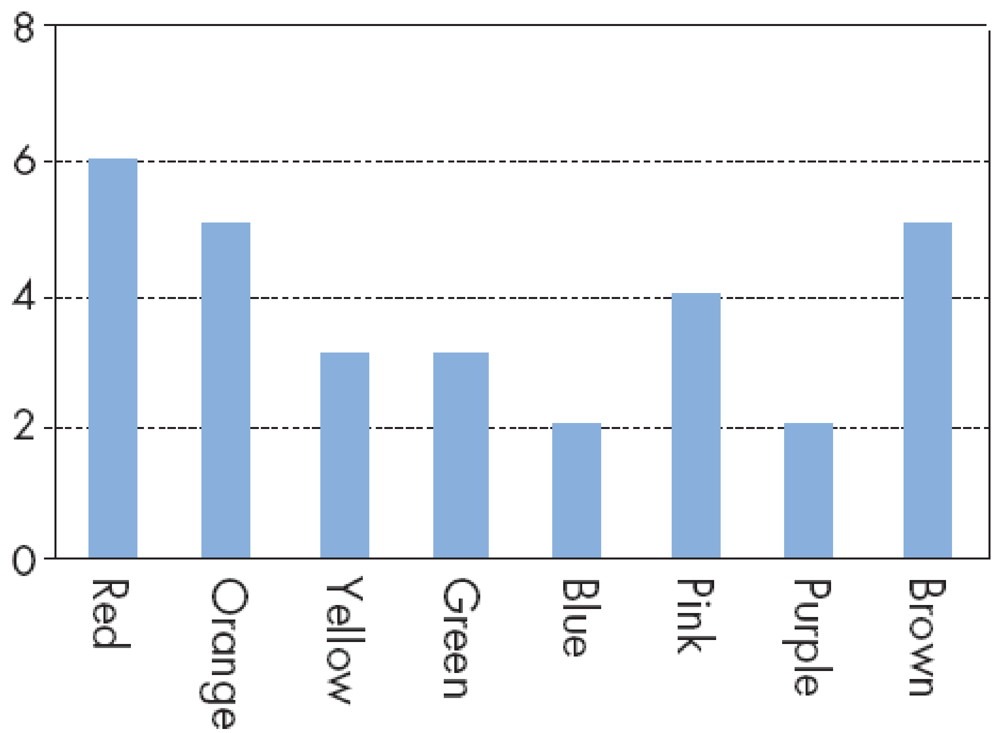
Q: 10 To complete one set of bookshelves a carpenter needs the following components.

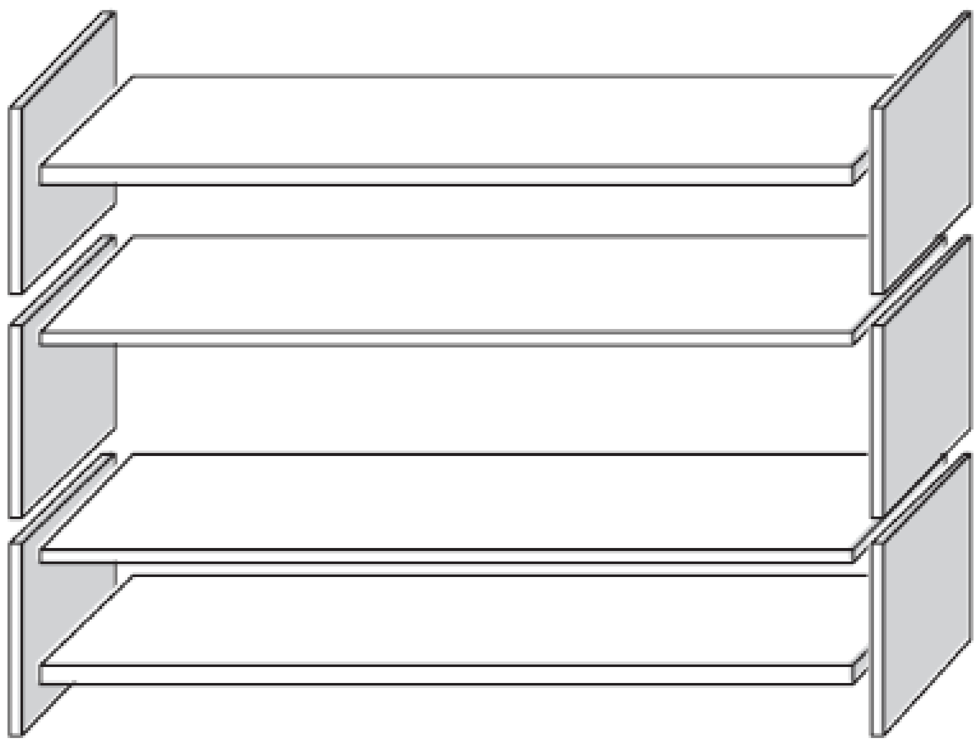
4 long wooden panels, 6 short wooden panels, 12 small clips, 2 large clips and 14 screws.

The carpenter has in stock 26 long wooden panels, 33 short wooden panels, 200 small clips, 20 large clips and 510 screws. How many book shelves can the carpenter make?

Answer:

Place	Time
Sydney	
Berlin	





Appendix F: Interview Schedules

Indicative interview schedule

For students

1. What is your name?
2. How old are you?
3. How many siblings you have?
4. Who helps you with your study?
5. Do you think mathematics is important in your future work? In what ways? Why? / Why not?
6. How do you rate yourself as a mathematics student?
7. How do you feel about it? Why?
8. What is your worst subject in school?
9. How do you feel when taking a mathematics test?
10. Which mathematics course are you studying now?
11. Why did you choose this course?
12. In what ways, if any,are your parents involved in your mathematics learning?
13. How often do your parents check your homework?
14. Who help you with your maths work?

15. Do your parents monitor the time you spend watching TV? Why? / How?
16. What is your parent's opinion about your achievement in mathematics?
17. Do your parents monitor the time you spend on mathematics? Why?/ How?
18. What do you want to do when you finish secondary school? Why?
19. What is your view about working hard in studies, particularly in mathematics?
20. What do you think is your parents' expectation about your achievement in school?
21. What do you think your parents would like you to do when you finish secondary school? Why?
22. In what ways do your parents help you in making decisions about your maths studies?

For parents

1. What is your name?
2. How many children you have?
3. What do you do for living?
4. How much are you involved with your child's schooling?
5. How do you help your child with his/her studies?
6. How often do you check his/ her home work?
7. How much are you involved with your child' mathematics learning?

8. How do you help your child with the maths home work?
9. Do you check the assessment results of your child in mathematics? Why?
10. What is your opinion about your child's achievement in mathematics?
11. How often do you monitor the time your child spends on mathematics?
12. How do you monitor the time your child spends on activities other than studies like watching TV, playing games, socialising etc?
13. How often do you consult your child's teacher about his/her mathematics performance?
14. What is your view about working hard in studies, particularly in mathematics?
15. What is your opinion about your child's achievement in mathematics?
16. Which was your worst subject in school?
17. How do you help your child to make decisions about his/her studies?
18. What is your expectation about your child's achievement in school?
19. What do you want your child to do when he/she finish secondary school? Why?
20. How do you encourage your child in his/her studies?

Appendix G: Ethics Approval Letter

Social Science Ethics Officer
Private Bag 01 Hobart
Tasmania 7001 Australia
Tel: (03) 6226 2763
Fax: (03) 6226 7148
Katherine.Shaw@utas.edu.au

HUMAN RESEARCH ETHICS COMMITTEE (TASMANIA) NETWORK

27 September 2011

Assoc Prof Kim Beswick
Faculty of Education
Locked Bag 1307
Launceston Tasmania

Student Researcher: Mini Joseph Chaman

Dear Assoc Prof Beswick

Re: FULL ETHICS APPLICATION APPROVAL
Ethics Ref: **H0011986 - The influence of parental involvement, students' mathematics anxiety and attitude towards mathematics on their mathematics achievement in Australia and India**

We are pleased to advise that the Tasmania Social Sciences Human Research Ethics Committee approved the above project on 26 September 2011.

Please note that this approval is for four years and is conditional upon receipt of an annual Progress Report. Ethics approval for this project will lapse if a Progress Report is not submitted.

The following conditions apply to this approval. Failure to abide by these conditions may result in suspension or discontinuation of approval.

1. It is the responsibility of the Chief Investigator to ensure that all investigators are aware of the terms of approval, to ensure the project is conducted as approved by the Ethics Committee, and to notify the Committee if any investigators are added to, or cease involvement with, the project.

2. Complaints: If any complaints are received or ethical issues arise during the course of the project, investigators should advise the Executive Officer of the Ethics Committee on 03 6226 7479 or human.ethics@utas.edu.au.

3. Incidents or adverse effects: Investigators should notify the Ethics Committee immediately of any serious or unexpected adverse effects on participants or unforeseen events affecting the ethical acceptability of the project.

4. Amendments to Project: Modifications to the project must not proceed until approval is obtained from the Ethics Committee. Please submit an Amendment Form (available on our website) to notify the Ethics Committee of the proposed modifications.

5. Annual Report: Continued approval for this project is dependent on the submission of a Progress Report by the anniversary date of your approval. You will be sent a courtesy reminder closer to this date. **Failure to submit a Progress Report will mean that ethics approval for this project will lapse.**

6. Final Report: A Final Report and a copy of any published material arising from the project, either in full or abstract, must be provided at the end of the project.

Yours sincerely

Katherine Shaw
Acting Executive Officer

Appendix H: Permission Letter from Principal

Dr. Cherian Panicker,
Principal,
Sarvodaya Central Vidhyalaya,
Thiruvananthapuram,
Kerala, India.

To

Mini Joseph Chaman,
PhD candidate, Faculty of education,
University of Tasmania,
Hobart.

Dear Mini Chaman,

Ref: Your email dt 25th Oct 2011 requesting permission to conduct research study in our school.

I am writing to you in response to your request to conduct research study in our school among Year 9 to 12 students in relation to your research topic "The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in Australia and India".

I hereby permit you to conduct the research among Year 9 to 12 students and collect necessary data pertaining to your research. As requested by you I give permission to conduct achievement test, questionnaire and interview among selected students and also to conduct questionnaire and interview among their parents.

The staff members of our school are happy to provide any required assistance to you in this regard.

Wishing you all the success in your research.

Yours Sincerely

03.11.2011

SARVODAYA CENTRAL VID...IA TRIVANDRUM-15

Dr. Cherian Panicker

Principal
Sarvodaya Central Vidyalaya
Trivandrum - 695 015

Appendix I: Consent Forms

Locked Bag 1307 Launceston
Tasmania 7275 Australia

FACULTY OF EDUCATION

TEACHER CONSENT FORM

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. The nature of the project has been explained to me.
2. I understand that my involvement in the study involves distribution and collection of information sheets, consent forms and completed tests, student questionnaires and parent questionnaires and administering a mathematics achievement test and student questionnaire to mathematics class (es). The test and questionnaire will each take approximately 40 minutes.
3. I understand that my participation in the study involves no risk.
4. I understand that the researcher will maintain my identity confidential and that any information I supply to the researcher will be used only for the purpose of the research.
5. I agree to assist in the research study.

Name of the teacher:

Signature of the teacher: Date:

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: K Beswick Date: 24.10.2011

Name of investigator: Assoc Prof Rosemary Callingham

Signature of investigator: RA Callingham Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: MJChaman Date: 24.10.2011

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Tasmania 7275 Australia

FACULTY OF EDUCATION

PARENT CONSENT FORM FOR STUDENT QUESTIONNAIRE AND TEST

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that the study involves **completion of an achievement test in mathematics of approximately 40 minutes duration and completion of a questionnaire (40 minutes duration)** in class.
4. I understand that participation in the research project is low risk.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from my child for the study may be published provided that my child cannot be identified as a participant.
7. I understand that the researcher will maintain my child's identity confidential and that any information he/she supply to the researcher will be used only for the purpose of the research.
8. I give consent for my child to participate in this investigation and understand that my child may withdraw at any time without any effect, if so he/she wish, may request that any data my child have supplied to date may be withdrawn from the research.

Name of the Student:

Name of Parent/ Guardian:

Signature of Parent/ Guardian: Date:

Statement by the investigator:

☑ The participant has received the Information Sheet where my details has been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: KBeswick Date: 24.10.2011

Name of investigator: Assoc Prof Rosemary Callingham

Signature of investigator: RACallingham Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: MJChaman Date: 24.10.2011

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Tasmania 7275 Australia

FACULTY OF EDUCATION

STUDENT CONSENT FORM FOR TEST

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that the study involves **completion of an achievement test in mathematics of approximately 40 minutes duration**.
4. I understand that participation in the research project is low risk.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
7. I understand that the researcher will maintain my identity confidential and that any information I supply to the researcher will be used only for the purpose of the research.
8. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, if so I wish, may request that any data I have supplied to date may be withdrawn from the research.

Name of the Student:

Signature of Student: Date:

Statement by the investigator:

☑ The participant has received the Information Sheet where my details has been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: K Beswick Date: 24.10.2011

Name of investigator: Assoc Prof Rosemary Callingham

Signature of investigator: Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: Date: 24.10.2011

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Tasmania 7275 Australia

FACULTY OF EDUCATION

UTAS

STUDENT CONSENT FORM FOR QUESTIONNAIRE

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that the study involves **completion of a questionnaire of approximately 40 minutes duration.**
4. I understand that participation in the research project is low risk.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
7. I understand that the researcher will maintain my identity confidential and that any information I supply to the researcher will be used only for the purpose of the research.
8. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, if so I wish, may request that any data I have supplied to date may be withdrawn from the research.

Name of the Student:

Signature of Student: Date:

Statement by the investigator:

☑ The participant has received the Information Sheet where my details has been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: KBeswick Date: 24.10.2011

Name of investigator: Assoc Prof Rosemary Callingham

Signature of investigator: RA Callingham Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: MJChaman Date: 24.10.2011

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Tasmania 7275 Australia

FACULTY OF EDUCATION

PARENT CONSENT FORM FOR STUDENT INTERVIEW

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that my child has been selected for **an interview of approximately 30 minutes** to discuss about the influence of parental involvement, students' mathematics anxiety and attitude towards mathematics on their mathematics achievement.
4. I understand that participation in the research project is low risk, with only foreseeable risk being the possibility of discomfort or anxiety during the interview.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from my child for the study may be published provided that he/she cannot be identified as a participant.
7. I understand that the researcher will maintain my child's identity confidential and that any information my child supplies to the researcher will be used only for the purpose of the research.
8. I give consent for my child to participate in this investigation and understand that my child may withdraw at any time without any effect, if so he/she wish, may request that any data my child have supplied to date may be withdrawn from the research.

Name of the Student:

Name of the Parent:

Signature of the Parent: Date:

Statement by the investigators:

☑ The participant has received the Information Sheet where my details has been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: KBeswick Date: 24.10.2011

Name of investigator: Assoc Prof Rosemary Callingham

Signature of investigator: RA Callingham Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: MJChaman Date: 24.10.2011

Locked Bag 1307 Launceston
Tasmania 7275 Australia

FACULTY OF EDUCATION

STUDENT INTERVIEW CONSENT FORM

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that I have been selected for **an audio taped interview of approximately 30 minutes** to discuss about the influence of parental involvement, students' mathematics anxiety and attitude towards mathematics on their mathematics achievement.
4. I understand that participation in the research project is low risk and the only foreseeable risk is one of discomfort or anxiety during the interview.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
7. I understand that the researcher will maintain my identity confidential and that any information I supply to the researcher will be used only for the purpose of the research.
8. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, if so I wish, may request that any data I have supplied to date may be withdrawn from the research.

Name of the Student:

Signature of the Student: Date:

Statement by the investigator:

☑ The participant has received the Information Sheet where my details has been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: Date: 24.10.2011

Name of investigator: Assoc Prof Rosemary Callingham

Signature of investigator: Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: Date: 24.10.2011

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Tasmania 7275 Australia

FACULTY OF EDUCATION

UTAS

PARENT CONSENT FORM FOR QUESTIONNAIRE

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that the study involves **completion of a questionnaire** (**about 20 minutes duration)**.
4. I understand that participation in this aspect of the research project involves no foreseeable risk.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
7. I understand that the researcher will maintain my identity confidential and that any information I supply to the researcher will be used only for the purpose of the research.
8. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, if so I wish, may request that any data I have supplied to date may be withdrawn from the research.

Name of Parent/ Guardian:

Signature of Parent/ Guardian: Date:

Statement by the investigator:

☑ The participant has received the Information Sheet where my details has been provided so the participant have the opportunity to contact me prior to consenting to participate in this project.

Name of investigator: Assoc Prof Kim Beswick

Signature of investigator: KBeswick Date: 24.10.2011

Name of investigator Assoc Prof Rosemary Callingham

Signature of investigator: RACallingham Date: 24.10.2011

Name of investigator: Mrs. Mini Joseph Chaman

Signature of investigator: MJChaman Date: 24.10.2011

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Tasmania 7275 Australia

FACULTY OF EDUCATION

PARENT INTERVIEW CONSENT FORM

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

1. I have read and understood the 'Information Sheet' for this project.
2. The nature and the possible effects of the project have been explained to me.
3. I understand that I have been selected for **an audio taped interview of approximately 30 minutes** to discuss the influence of parental involvement, mathematics anxiety and attitude towards mathematics on mathematics achievement.
4. I understand that participation in the research project is low risk, with only foreseeable risk being the possibility of discomfort or anxiety during the interview.
5. I understand that all research data will be securely stored on the University of Tasmania premises for at least five years, and will be destroyed when no longer required.
6. I agree that research data gathered from me for the study may be published provided that I cannot be identified as a participant.
7. I understand that the researcher will maintain my identity confidential and that any information I supply to the researcher will be used only for the purpose of the research.
8. I agree to participate in this investigation and understand that I may withdraw at any time without any effect, if so I wish, may request that any data I have supplied to date may be withdrawn from the research.

Name of Parent/ Guardian:

Signature of Parent/ Guardian: Date:

Please provide your preferred contact details (email or telephone) to negotiate a mutually convenient time and place for the interview.
Email ID: Telephone Number:

Statement by the investigator:

✓ The participant has received the Information Sheet where my details has been provided so participants have the opportunity to contact me prior to consenting to participate in this project.

Name of the investigator: Assoc Prof Kim Beswick

Signature of the investigator: KBeswick Date: 24.10.2011

Name of the investigator: Assoc Prof Rosemary Callingham

Signature of the investigator: Date: 24.10.2011

Name of the investigator: Mrs. Mini Joseph Chaman

Signature of the investigator: Date: 24.10.2011

Appendix J: Information Sheets

Locked Bag 1307 Launceston
Tasmania 7275 Australia

FACULTY OF EDUCATION

STUDENT INFORMATION SHEET FOR TEST, QUESTIONNIARE AND INTERVIEW

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

You are invited to participate in a research study to investigate the influence of parental involvement, mathematics anxiety and attitude towards mathematics on students' mathematics achievement. The study is being conducted in partial fulfillment of a PhD for Mrs Mini Joseph Chaman under the supervision of Associate Professors Kim Beswick and Rosemary Callingham.

What is the purpose of the study?
The purpose of the study is to investigate whether parental involvement, mathematics anxiety and attitude towards mathematics influence students' mathematics achievement.

Why have I been invited to participate in this study?
Your school has agreed to participate in the study. You are eligible to participate in the study because you are studying mathematics in Years 9-12.

What does this study involve?
If you agree to participate in this study, you will be asked to complete mathematics test that should take approximately 40 minutes and to complete a questionnaire of approximately 40 minutes on your attitude to mathematics. The test is only for the research and your performance on it will not affect your grade or result in mathematics. You may also be invited to participate in an audio taped interview of approximately 30 minutes to discuss about your attitude to mathematics.

It is important to understand that your involvement in the study is voluntary. While we would be pleased to have you participate and we respect your right to decline. Your decision not to participate will not have any consequences for your mathematics results. If you decide to discontinue your participation at any time, you may do so without providing an explanation. All information will be treated in a confidential manner and your name will not be used anywhere in the research. All research data will be stored in locked filing cabinets and password protected files at the Sandy Bay campus of University of Tasmania. All the data collected (hard copies, text files and audio tapes) will be destroyed after five years from the date of publication of the study.

Are there any possible benefits from participation in this study?

You may come to a better understanding of your interaction with mathematics in relation to mathematics anxiety, attitude towards mathematics and parental involvement and may get insights to improve your mathematics learning.

What if I have questions about the study?

If you have any questions relating to this study, feel free to contact any of the investigators, on +61 3 62262536 or Email: mjchaman@utas.edu.au or +61 3 63243167 or Email: Kim.Beswick@utas.edu.au or +61 3 63243051 or Email: Rosemary.Callingham@utas.edu.au. We would be happy to discuss any aspect of the research with you.

This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, should contact the Executive Officer of the HREC (Tasmania) Network on +61 3 6226 7479 or Email: human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote HREC Project Number: H0011986.

Thank you for taking the time to consider this study. If you wish to take part in the study, please sign the consent form at the front of the test and questionnaire. This information sheet is for you to keep.

Locked Bag 1307 Launceston
Tasmania 7275 Australia

FACULTY OF EDUCATION

PARENT INFORMATION SHEET FOR STUDENT INTERVIEW

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

Your child is invited to participate in an interview to investigate the influence of parental involvement, mathematics anxiety and attitude towards mathematics on students' mathematics achievement. The study is being conducted in partial fulfillment of a PhD for Mrs Mini Joseph Chaman under the supervision of Associate Professors Kim Beswick and Rosemary Callingham.

What is the purpose of the study?
The purpose of the study is to investigate whether parental involvement, mathematics anxiety and students' attitude towards mathematics influence their mathematics achievement.

Why has my child been invited to participate in this study?
Your child's school has agreed to participate in this study. You child is eligible to participate in the study because the participants for the study are chosen to be secondary school students in Years 9-12.

What does this study involve?
You child will be invited to participate in an audio taped interview for approximately 30 minutes regarding his/her attitude to and feelings about mathematics which will take place at a convenient time for all involved.

It is important to understand that your child's involvement in the study is voluntary, while we would be pleased to have your child's participation and we respect your right to decline. If your child decides to discontinue his/her participation at any time, he/she may do so without providing an explanation. All information will be treated in a confidential manner and your child's name will not be used anywhere in the research. All research data will be stored in locked filing cabinets and password protected files at the Sandy Bay campus of University of Tasmania. All the data collected (hard copies, text files and audio tapes) will be destroyed after five years from the date of publication of the study.

Are there any possible benefits from participation in this study?
Your child may come to a better understanding of his/her interaction with mathematics. This study may lead to possible discussions between you and your child about mathematics learning. In the unlikely event that your child experiences anxiety or any discomfort during the interview he/she will be able to ask that the interview be discontinued, decline to answer any or all questions or to withdraw data already provided.

What if I have questions about the study?

If you have any questions relating to this study, feel free to contact any of the investigators, on +61 3 62262536 or Email: mjchaman@utas.edu.au or +61 3 63243167 or Email: Kim.Beswick@utas.edu.au or +61 3 63243051 or Email: Rosemary.Callingham@utas.edu.au. We would be happy to discuss any aspect of the research with you.

This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, should contact the Executive Officer of the HREC (Tasmania) Network on +61 3 6226 7479 or Email: human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote HREC Project Number: H0011986.

Thank you for taking the time to consider this study. If you wish your child to take part in the study, please sign the attached consent form, place it in the envelope provided and return it to your child's mathematics teacher who will pass it on to the researchers. This information sheet is for you to keep.

Locked Bag 1307 Launceston
Tasmania 7275 Australia

FACULTY OF EDUCATION

PARENT INFORMATION SHEET FOR QUESTIONNAIRE AND INTERVIEW

The influence of parental involvement, and students' mathematics anxiety and attitude towards mathematics, on their mathematics achievement in India.

You are invited to participate in a research study to investigate the influence of parental involvement, anxiety and attitude towards mathematics on students' mathematics achievement. The study is being conducted by in partial fulfillment of a PhD for Mrs Mini Joseph Chaman under the supervision of Associate Professors Kim Beswick, and Rosemary Callingham.

What is the purpose of the study?

The purpose of the study is to investigate whether parental involvement, students' mathematics anxiety and attitude towards mathematics influence their mathematics achievement. The study also aims to investigate the interrelationship between the above mentioned factors and to understand whether cultural differences affect the role of parental involvement, mathematics anxiety and students' attitude towards mathematics in influencing their mathematics achievement.

Why have I been invited to participate in this study?

The study investigates the influence of parental involvement on mathematics achievement of students. As the parent of a secondary / higher secondary student, the information provided by you is vital for the study to understand parental influence and thus will help to improve the mathematics learning of secondary school students.

What does this study involve?

If you agree to participate in this study, you will be asked to complete the enclosed questionnaire of approximately 20 minutes on parental involvement, mathematics anxiety and attitude towards mathematics. You may also be asked to participate in an interview for approximately 30 minutes regarding any or all of the above mentioned areas, which will take place at a convenient time for all involved.

It is important to understand that your involvement in the study is voluntary, while we would be pleased to have you participate and we respect your right to decline. If you decide to decline your participation at any time, you may do so without providing an explanation. All information will be treated in a confidential manner and your name will not be used anywhere in the research. All research data will be stored in locked filing cabinets and password protected files at the Sandy Bay campus of University of

Tasmania. All the data collected (hard copies, text files and audio tapes) will be destroyed after five years from the date of publication of the study.

Are there any possible benefits from participation in this study?
You may come to a better understanding of your involvement in your child's mathematics achievement and things to be done to help your child. In the unlikely event that you experience anxiety or any discomfort during the interview you will be able to ask that the interview be discontinued, decline to answer any or all questions or to withdraw the data already provided.

What if I have questions about the study?
If you have any questions relating to this study, feel free to contact either myself on +61 3 62262536 or Email: mjchaman@utas.edu.au or +61 3 63243167 or Email: Kim.Beswick@utas.edu.au or +61 3 63243051 or Email: Rosemary.Callingham@utas.edu.au. We would be happy to discuss any aspect of the research with you.

This study has been approved by the Tasmanian Social Science Human Research Ethics Committee. If you have concerns or complaints about the conduct of this study, should contact the Executive Officer of the HREC (Tasmania) Network on +61 3 62267479 or Email: human.ethics@utas.edu.au. The Executive Officer is the person nominated to receive complaints from research participants. You will need to quote HREC Project Number: H0011986.

Thank you for taking the time to consider this study. This information sheet is for you to keep.

Appendix K: Interview transcripts

Interview transcript of Student: Maya

Interviewer:	What's your name?
Maya:	Maya.
Interviewer:	How old are you?
Maya:	14.
Interviewer:	How many siblings do you have? That means brothers or sisters.
Maya:	One.
Interviewer:	Who helps you with your study?
Maya:	Brother.
Interviewer:	Do you think mathematics in important in your future work?
Maya:	Yes.
Interviewer:	In what ways? Whether in your future career or you're going to study further or ...
Maya:	I wish to study, but my ambition is to become a doctor.
Interviewer:	Okay. How do you rate yourself as a mathematics student?
Maya:	Not bad.
Interviewer:	Can you explain a bit more?
Maya:	Not very much, I don't know mathematics very much, but ...
Interviewer:	How do you feel about yourself rating yourself as an ... what you've just told about your mathematics achievement?
Maya:	It's okay.
Interviewer:	Or do you feel you can do better or ...
Maya:	I can do better, I could.

Interviewer:	What is your worst subject in school?
Maya:	English.
Interviewer:	How do you feel when taking a mathematics test?
Maya:	Nervous.
Interviewer:	Which mathematics course are you studying now? You just explain what ... which year and what you're studying in your maths class? Can you explain that ... do you want me to repeat?
Maya:	Yes.
Interviewer:	Which mathematics course are you studying now?
Maya:	Mathematics ...
Interviewer:	Course. That means what all subjects, what all topics you're studying in your maths class?
Maya:	Algebraic expressions, then geometries, triangles, circles.
Interviewer:	In what ways are your parents involved in your mathematics learning? Do you've anything to say?
Maya:	No.
Interviewer:	How often do your parents check your homework?
Maya:	They never look.
Interviewer:	Who helps you with your mathematics work? That means daily work, homework or whatever related to maths?
Maya:	My brother.
Interviewer:	Do your parents monitor the time you spend watching TV?
Maya:	Yes.
Interviewer:	Why?
Maya:	We've a lot to study, so that they will monitor.
Interviewer:	Monitor how you watch the TV. How do they monitor the...your time spending on watching TV?
Maya:	There is time limit for me to see the TV.

Interviewer:	Okay. What's your parents' opinion about your achievement in maths?
Maya:	They will ask me to improve.
Interviewer:	Okay. What are your views about working hard in studies particularly in maths? What is your view about working hard in studies particularly in maths, whether you have to work hard in your studies or is it ...
Maya:	Work hard.
Interviewer:	You have to work hard. Why do they say you have to work hard in studies? Why? Why do you have to work hard?
Maya:	To score good marks.
Interviewer:	For what? Do you want me to go to the next one?
Maya:	Yes.
Interviewer:	What do you think is your parents' expectation about your achievement in school? What do they think you can achieve in school?
Maya:	Hard work, achieve the top.
Interviewer:	Okay. What do you think your parents would like you to do when you finish secondary school? That's when you finish Year-12, what do you think your parents expect you to do?
Maya:	Parents ...
Interviewer:	We will go the next one. In what ways do your parents help in making decisions about your maths studies?
Maya:	Maths studies?
Interviewer:	In what ways your parents help you in making decisions about your maths studies? Whether they ask you to study hard or do on the problems or do on the...all the exercises in your maths book or ...
Maya:	All the exercises in maths.
Interviewer:	Okay. Thank you.

Interview transcript of Parent: Baby

Interviewer:	What is your name?
Translator:	What is your name?
Baby:	Baby.
Interviewer:	How many children do you have?
Translator:	How many children do you have?
Baby:	Two.
Interviewer:	What do you do for a living?
Translator:	What's your job?
Baby:	I'm working in a society.
Translator:	He is working in a society.
Interviewer:	How much are you involved with your child's schooling?
Translator:	What's your role in your children's schooling?
Baby:	I'm involved in 95% of it.
Translator:	He is involved almost 95% in their schooling.
Interviewer:	How do you help your child with her studies?
Translator:	How are you helping your children in their studies?
Baby:	What I meant by helping is that... I can't help by teaching them, but... I help them other ways.
Translator:	I'm helping them not directly with their studies, but generally I'm helping them to..... all their ..... looking after their studies.
Baby:	I don't have the knowledge to teach them CBSE... for my children.
Translator:	I'm not capable of teaching the subjects in the CBSE syllabus.
Interviewer:	How often do you check her homework?
Translator:	Do you often check your homework?
Baby:	Yes, I do.
Translator:	I use to check their homework regularly.

Interviewer:	How do you help your child with the maths homework?
Translator:	Do you help your children's maths homework?
Baby:	No.
Translator:	No.
Interviewer:	Do you check the assessment result of your child in maths?
Translator:	Do you check your children's progress report?
Baby:	Yes I do.
Translator:	He used to check their progress report.
Interviewer:	Why?
Translator:	Why are you doing that?
Baby:	I'm doing it to get more marks and to get more improvement.
Translator:	I'm interested so that my children get good marks and also they improve their studies.
Interviewer:	What's your opinion about your child's achievement in maths?
Translator:	Do you have anything to say about your children's mathematics improvement?
Baby:	I'm happy, it has improved.
Translator:	I'm happy that their mathematical studies are improving.
Interviewer:	How often do you monitor the time your child spends on maths?
Translator:	Do you watch how much time your kids spend on maths?
Baby:	I don't watch it specifically.
Translator:	Specifically I don't watch that.
Interviewer:	How do you monitor the time your child spends on activities other than studies like watching TV, playing games, socializing et cetera?
Translator:	Excluding studies, other activities like sports, TV, do you observe how much time your kids spend on that?
Baby:	Yes, I do.
Translator:	Yes, I use to monitor. How are you doing that?

Baby:	I'm allowing my kids to involve in these activities only on Saturdays and Sundays. In the remaining days they use to do their studies.
Translator:	Only on Saturdays and Sundays I use to permit them for other activities. In the remaining days they use to do their studies.
Interviewer:	How often do you consult your child's teacher about her mathematics performance?
Translator:	How many times do you consult with your child's teacher about their mathematics performance?
Baby:	When my children gets their progress card we've to get there, during that time I consult with the teacher. We don't consult the teachers at other times.
Translator:	When I receive their progress card I use to talk with their teacher. Apart from that I don't have any communication with the teacher apart from asking them when I receive their progress card.
Interviewer:	What is your view about working hard in studies particularly in maths?
Translator:	Do you believe your child should work hard in studies, particularly in mathematics?
Baby:	Mathematics is the most important subject. I always tell my children to hard work on maths. That's what I'm trying to.
Translator:	I feel that mathematics is an important subject, and I want my children to work hard and achieve high in mathematics.
Interviewer:	Which was your worst subject in school?
Translator:	During your study days what was your worst subject?
Baby:	If I tell the truth it's maths.
Translator:	To be honest, it is mathematics.

Interviewer:	How do you help your child to make decision about her studies?
Translator:	How do you help your children to decide their future studies?
Baby:	I use to enquire their opinion and I give priority to their opinion. I don't force them to choose my opinion. Their opinion is important.
Translator:	I use to enquire about their opinion and I give more importance for their opinion rather than imposing my opinion on them.
Interviewer:	What is your expectation about your child's achievement in school?
Translator:	What do you think about your child's achievement in school?
Baby:	I wish they achieve well in school.
Translator:	I would like very much so that my children doing academically well in their school studies.
Interviewer:	What do you want your child to do when she finish secondary school?
Translator:	What do you want your daughter to become after finishing school years?
Baby:	My daughter's ambition is to become a doctor. I will help her for that.
Translator:	My daughter is willing to become a doctor. And I will help her in all my ways to achieve her aim.
Interviewer:	How do you encourage your child in her studies?
Translator:	How do you encourage your child in her studies?
Baby:	I help her in all ways that I could possibly do. I do encourage them.
Translator:	I use to help them. I use to provide all the required help to do their studies well. And I use to give them a general guidance for them.

Interview transcript of Student: Meenu

Interviewer:	What is your name?
Meenu:	Meenu.
Interviewer:	How old are you?
Meenu:	16.
Interviewer:	How many siblings do you have?
Meenu:	One.
Interviewer:	Who helps you with your study?
Meenu:	Father.
Interviewer:	Please raise your voice when you speak. Do you think mathematics is important in your future work?
Meenu:	Yes.
Interviewer:	In what ways? You have to explain why you think maths is more important in your future life, whether you're going to use it for your career or further study or...
Meenu:	I don't know.
Interviewer:	Okay. How do you rate yourself as a mathematics student? Just again, say what you think about yourself in maths?
Meenu:	I think maths is an easy subject, but I find it very difficult to solve the problems in my examinations.
Interviewer:	Is it only in particular topic or... I mean, geometry or algebra or all maths as a whole you're finding it hard to solve the...
Meenu:	No, particular problem.
Interviewer:	Can you explain which topic you find hard to study? How do you feel about yourself rating... your rating as a maths student? What do you think? When you're saying in maths you're finding it hard to solve problems in the examination, can you say that how do you feel? We can share your thoughts. You're not having anything to say? What's your worst subject in the school?
Meenu:	History.

Interviewer:	Okay. How do you feel when taking a mathematics test?
Meenu:	How do I feel...
Interviewer:	How do you feel when taking a mathematics test?
Meenu:	I feel... I feel my mind went blank.
Interviewer:	Do you feel nervous or tensed or... and when you feel nervous you're finding it hard to solve... solve the problems or...
Meenu:	I'll forget all the equations...
Interviewer:	Okay.
Meenu:	Formulas.
Interviewer:	Okay. Because you're getting tensed is it affecting the final result? Have you thought about that?
Meenu:	No.
Interviewer:	Even though you're forgetting the equations and everything you're able to finish the whole test, is what happening or you won't be able to finish the whole test?
Meenu:	I don't get enough time to complete all the questions.
Interviewer:	Just because you're getting tensed, not because you don't know it?
Meenu:	I know it.
Interviewer:	You know all the... you've studied everything and you know the portions, but because you're nervous you won't be able to finish the test, is that what you mean?
Meenu:	Not like that. I... I will split [Ph] some of the portions.
Interviewer:	When you're studying, why?
Meenu:	I find it difficult to study that... those portions.
Interviewer:	Okay. Which mathematics course are you studying? That means which are the topics you're studying in maths, like algebra, geometry, anything else you're studying in Year-11. I think there maybe specific topics, coordinates in geometry and something...
Meenu:	Yes, coordinates.

Interviewer:	Anything else other than these?
Meenu:	Limits and elementary...
Interviewer:	Pardon.
Meenu:	Limits and derivatives.
Interviewer:	Okay. Functions or... do you have differentiation?
Meenu:	Yes.
Interviewer:	Calculus, I think. Okay. In what ways if any are your parents involved in your mathematics learning? How your parents are helping in your maths learning?
Meenu:	No, they don't help me.
Interviewer:	How often do your parents check your homework?
Meenu:	How long...
Interviewer:	Maybe everyday or regularly or once in a week or...
Meenu:	Not at all.
Interviewer:	Who help you with your maths work?
Meenu:	Tuition.
Interviewer:	Do your parents monitor the time you spend watching TV?
Meenu:	Yes.
Interviewer:	Why? They may have a reason for monitoring the time you spend on watching TV, why?
Meenu:	No, I cannot...
Interviewer:	You cannot say why they are monitoring the time?
Meenu:	How can I say that?
Interviewer:	I think my mother is not going to... Whether they ask you to study during the week or during the weekends you're...you can spend some time watching the TV or... what do you watch... you won't watch the TV at all, what happens?
Meenu:	My TV is not working properly...

Interviewer:	I think you've to raise your voice a bit so that I can get it better. What is your parents' opinion about your achievement in maths? Whether they're satisfied or whether they want you to improve or...
Meenu:	They want... want me to improve.
Interviewer:	Do your parents' monitor the time you spend in mathematics? Whether they check how much, how long you will spend doing maths or...
Meenu:	Yes.
Interviewer:	Can you explain why they're checking the time you spend on doing maths? It's better to (07:50) _______ move from there. What do you want to do when you finish secondary school, when you... when you finish Year-12?
Meenu:	Ambition?
Interviewer:	Yeah.
Meenu:	Doctor.
Interviewer:	Why? Do you've a reason for choosing the profession of a doctor? There maybe a reason behind it, is it? What's the reason?
Meenu:	No reason.
Interviewer:	What's your view about working hard in studies, particularly in maths? Whether the students have to work hard in studies or...
Meenu:	Students have to work hard.
Interviewer:	Okay. What about in maths?
Meenu:	Maths, they've to... they've to do their daily problems.
Interviewer:	Okay.
Meenu:	Any portions taught in school.

Interviewer:	Do they have to work hard on the daily on what is taught in the class, what's the purpose of that? If you're studying history there is no need to study everyday.
Meenu:	No.
Interviewer:	You can read it at the... maybe at the end of the week or... why we've to work hard in maths? What is... what do you think is your parents' expectation about your achievement in the school?
Meenu:	Expectations?
Interviewer:	What they think about, how... how much you've to achieve, what they've... they're thinking of achieving from your part?
Meenu:	They want me to be... they want me to score above 90%.
Interviewer:	Okay. What do you think your parents would like you to do when you finish secondary school? What do they want you to do when you finish Year-12?
Meenu:	Go for medicine.
Interviewer:	Can you say why they're... they're having that expectation of yourself doing medicine? In what ways your parents help you in making decisions about your maths studies?
Meenu:	Making...
Interviewer:	... decisions about your maths studies? Whether they give you some instruction how to study maths or how to prepare for the exams, and do they give any suggestions for you?
Meenu:	Yes.
Interviewer:	Can you explain?
Meenu:	Doing problems...
Interviewer:	Okay. They ask you to do more problems to get better results for the exam?
Meenu:	Yes.
Interviewer:	Okay.

Interview transcript of Parent: Jaya

Interviewer:	What's your name?
Jaya:	Jaya
Interviewer:	How many children you have?
Jaya:	Two.
Interviewer:	What do you do for living?
Translator:	What's your job?
Jaya:	I'm working as a teacher.
Interviewer:	How much are you involved with your child's schooling?
Translator:	How much do you involve in your daughter's schooling?
Jaya:	For higher classes, I'm not able to teach her. But I use to tell her to study well. I advice her to repeat tough topics, repeatedly do mathematics problems, then, I use to tell her to study all days, not only days before the examination. I use to give advices like this to my daughter. I use to buy her books and stuffs.
Translator:	I find it very difficult to teach my kids, but I use to advice them how to study mathematics. I use to tell them that they have to do more problems and they have to do the regular homework. And I give them all the advices, but I won't be able to help them in their studies.
Interviewer:	How often do you check her homework?
Translator:	How often do you check your daughter's homework?
Jaya:	I don't generally check her homework.
Translator:	I generally won't check my daughter's homework.

Interviewer:	How much are you involved with your child's mathematics learning?
Translator:	How much are you involved with your child's mathematics learning?
Jaya:	I use to tell them, study by doing problems in mathematics, but as I can't teach them I've arranged tuition for her. I use to tell her only if you repeatedly do the problems in mathematics it would be easy for you. She had a tendency to study by-heart, but as I've advised her to study by doing, she is not studying by-heart anymore. She studies well for the exam, but she makes mistakes.
Translator:	I find it difficult to teach them, but I'm giving them tuition. Apart from that I used to advice how to study mathematics. Generally, my daughter used to learn by-heart the things, but when she goes for the exam, she is finding it difficult to solve the problems. Therefore I used to advice her to do the problems at home.
Interviewer:	Do you check the assessment result of your child in mathematics?
Translator:	Do you check your child's mathematics report card?
Jaya:	Progress report?
Translator:	Progress report.

Jaya: I use to check her progress report by going to her school. The teacher told it was bad. The teacher told she didn't worked hard. Teacher finished all her portions, but... her maths teacher is not that efficient to clear doubts for her. Teacher teaches using a guide. I use to tell my daughter to ask her doubts to teacher, to ask doubts to teachers and study. When my daughter asked doubts to the teacher, she couldn't help her. The teachers are not able to clear doubts by the children. I feel they are not that efficient. Only if the teachers are efficient they could bring forward the kids. But for maths... I could teach her basic mathematics, but in higher studies I can't teach. Nobody in my family is an expert in maths, her father is an expert in biology, I too don't have great knowledge in maths. The teachers are not at all efficient. We hope CBSE is good and we want our kids to improve, but the mathematics teachers are not good there. That's the problem.

Interviewer: Anyway I'll come to the next question.

Translator: I find... I used to check my daughter's report card. Last time I went to the school and asked the teacher about my daughter's mathematics performance. The teacher told me that her performance in mathematics is not good and she... the teacher told that... the teacher asked my daughter to do the problems, but yet she was not able to perform well in the examination. But I have a concern that the teacher... whenever my daughter is asking doubts to the teacher, the teacher is not able to answer properly her doubts. Therefore I've a concern about the ability of the teacher to teach well.

Interviewer:	Which was your worst subject in school?
Translator:	In your school days what was your worst subject?
Jaya:	English grammar and Chemistry.
Translator:	I don't like English grammar and Chemistry.
Interviewer:	How do you help your child to make decisions about her studies?
Translator:	How do you advice your kids about their future studies?
Jaya:	After Year-12... after Year-10 we didn't force her to take a specific subject. We let her choose. After Year-12 also we give the choice to my kid to select their topic. I use to tell her in order to achieve your desire you've to study hard. And I use to tell her only by getting good marks she would be able to go to college. I use to tell her college education is important. I never compel her anything to do, we just let her choose.
Translator:	When my daughter finished her year 10th studies we did not compel her to do or compel her to select some particular subjects. We have left it to our daughter to select her own subjects. Now when she completes year 12 also we won't be compelling her to select some particular course. It is up to her to select the subjects or the career which she wants. Now she has an ambition. If at all she wants to accomplish that ambition she has to really work hard. We are advising her to work hard to achieve that ambition. If she is doing good, she can go or reach that goal, otherwise she has to go to college studies, but college studies also equally good.

Translator: Now she has an ambition. If at all she wants to accomplish that ambition she has to really work hard.We are advising her to work hard to achieve that ambition. If she is doing good, she can go or reach that goal, otherwise she has to go to college studies, but college studies also equally good.

Interviewer: How do you monitor the time your child spends on activities other than studies, like, watching TV, playing games, socializing,et cetera?

Translator: Other than studies, do you observe how much time your kid spends on other activities like watching TV, spending time with friends, et cetera?

Jaya: As a teacher, my school time will be over by 3:30. When I reach home it would be around 4-4:30. Our TV is not functioning properly and there is no cable connection in it. So it doesn't matter much. Regarding Internet, I've asked her not to spend too much time on Internet. I use to tell her to use Internet only if needed. I use to tell her to watch only good things on Internet. After studying she uses Internet for some time. There is a time table for all those things. She goes to learn songs on two days a week. She doesn't have a lot of friends. Usually boys spend a lot of time with friends, but girls are not like that, they don't have lots of friends, they have friends at school. I don't compel her to study, but I give useful advices. I use to tell her not to spend too much time on Internet. She is not involved in outdoor games. I use to jog in the morning, so she is asking me to come with me. I don't generally feel she needs exercise at this stage.

Translator: Regarding watching TV, at present our TV is not working and also we don't have any cable connection. But even if TV is there I used to regulate the timings which my daughter is spending before TV. Apart from that we have an Internet connection. I have advised my daughter to use the internet properly and to see only the things which she really needs to look into the internet and we used to advise her not to waste her time on the internet, and the internet should be used only for the necessary things. Apart from regarding socializing, my daughter doesn't have much neighborhood where she can make friends. She has friends in her school. Apart from that, she doesn't have many friends near our house. And regarding games, specifically my daughter is not playing any particular game. I used to go for exercising or walking. My daughter used to request me to take her also along with me for walking, but generally I don't feel that she needs any exercise at this stage.

Interview transcript of Student: Tony

Interviewer:	What is your name?
Tony:	Tony.
Interviewer:	How old are you?
Tony:	14.
Interviewer:	How many siblings do you've?
Translator:	How many brothers do you have?
Tony:	One.
Translator:	One... I've one sibling.
Interviewer:	Who helps you with your study?
Translator:	Who helps you in your studies?
Tony:	Nobody.
Translator:	Nobody helps me.
Interviewer:	Do you think mathematics is important in your future work?
Tony:	Yes.
Translator:	Do you want to continue in English? Okay. Whenever there is some difficulty...
Interviewer:	I think when we have difficulty in understanding we'll translate to Malayalam, okay?
Tony:	Okay.
Interviewer:	In what ways you say mathematics is important? You can answer in Malayalam, he will translate. Whether it's going to help you in your future...
Tony:	Yes.

Interviewer:	... career or future studies when you go to college or... in which way you think maths is important?
Translator:	You can tell in Malayalam.
Tony:	Price of things...
Interviewer:	You can say whatever comes to your mind. Your daily work or when you go to shops or...
Tony:	Yeah. For buying things and all maths is important.
Translator:	I feel that it is important for commercial use as well as for other remaining things maths is important.
Interviewer:	I think you've to raise your voice then only it will get recorded, okay? How do you rate yourself as a maths student?
Translator:	How do you rate your level in maths? Is it medium or high achiever or low achiever, how do you view it?
Tony:	Average.
Translator:	He thinks he is an average student.
Interviewer:	How do you feel about your own rating as a maths student?
Translator:	As a maths student how do you evaluate yourself?
Tony:	Slightly above than average.
Interviewer:	No... what my question is you are saying you are an average student, how do you feel? That means whether you feel you can improve or you want to continue as an average student or...
Tony:	I can improve.

Interviewer:	You can... you feel that you can improve?
Tony:	Yes.
Interviewer:	Why you're feeling that you can improve? Because you're thinking you can improve...
Tony:	Yes.
Interviewer:	... there maybe a reason, why you feel that? Do you think you've the ability to do better or...
Tony:	Yes.
Interviewer:	Okay. What is your worst subject in school?
Tony:	Social science.
Interviewer:	How do you feel when taking a mathematics test?
Tony:	Anxiety.
Interviewer:	Once you're anxious, then... what happens when you are anxious?
Tony:	Mistake will happen...
Interviewer:	You've to say in complete sentence. When you're anxious what happens, when you're reading the question, when you're solving the problem what happens when you're anxious?
Tony:	When I do, mistakes happen because of my anxiousness.
Translator:	He finds that he commits mistakes when he is anxious during tests.
Interviewer:	And because you're anxious you're making mistakes, will you be able to complete the test in that particular time period?
Tony:	Sometimes.
Interviewer:	You're able to finish?
Tony:	Yes.

Interviewer:	Other times? Do you feel because you're anxious or you don't know how to do it, what's the reason... main reason?
Tony:	As mistakes happen, I have to redo it and it consumes a lot of time.
Translator:	Since he is making mistakes... many mistakes, he is not able to complete the test in time.
Interviewer:	Okay. Which mathematics course are you studying now? I'm asking... I'll explain the question, that's which all topics you're studying in maths like algebra, geometry...
Tony:	Quadrilaterals, areas of parallelogram, triangles, circles, geometry.
Interviewer:	And in what ways if any are your parents involved in your mathematics learning?
Translator:	Do your father and mother help you in your maths studies?
Tony:	They've arranged tuition.
Translator:	They've provided us tuition.
Interviewer:	How often do your parents check your homework?
Tony:	They don't check.
Translator:	They won't check my homework.
Interviewer:	Who help... help you with your maths work?
Tony:	Tuition sir.
Interviewer:	Do your parents monitor the time you spend watching TV?
Tony:	Yes.

Interviewer:	Why?
Tony:	If I'm watching TV during my study time, they will monitor me.
Translator:	If I'm watching TV during my study time, they will monitor me.
Interviewer:	Can you just explain how they monitor the time you spend on TV? Or else they won't allow you to watch the TV during the weekdays?
Translator:	How do your parents decide the time you spend watching TV is high? Or else they always monitor it? How do they control?
Tony:	They've given me a specific time.
Translator:	They have given me a specific time during which I'm permitted to watch TV.
Interviewer:	What is your parents' opinion about your achievement in mathematics?
Tony:	They ask to improve.
Interviewer:	Do your parents monitor the time you spend on mathematics?
Tony:	Not in mathematics, but overall they do.
Translator:	They don't monitor me specifically for mathematics; in overall studies they monitor my performance.
Interviewer:	Can you explain why they are checking you're... the time you spend on studies?
Tony:	They say I should study all subjects very well.
Translator:	They want me to give importance for all the subjects.
Interviewer:	What do you want to do when you finish secondary school? That means when you finish Year-12.
Tony:	Medicine.
Interviewer:	Why?
Tony:	My ambition is to be a doctor... to become a doctor.

Interviewer:	There maybe a reason for choosing that profession?
Tony:	Salary.
Interviewer:	Is that the only reason?
Tony:	Yes.
Interviewer:	What is your view about working hard in studies, particularly in maths? Whether the students has to work hard in studies or just go to school and bring something and get whatever they get or they have to work hard?
Tony:	Work hard.
Interviewer:	Why? Or in particular maths, do they have to work hard?
Tony:	Yes.
Interviewer:	Or when... is maths like any other subject, if it is History you've to read maybe after a week you can read whatever the teacher has taught in the class, is maths the same thing?
Tony:	No.
Interviewer:	You have a lot of subjects, right?
Tony:	Yes.
Interviewer:	In that, do you think mathematics have anything particular to study when compared to other subjects like Science, English, Malayalam, Hindi, Social Studies?Do you think you need to study maths in a particular way?
Tony:	We have to study maths in a particular way.
Interviewer:	Why?
Tony:	We can improve maths only through practice.
Translator:	I've to practice mathematical problems then only I can do well in maths.
Interviewer:	What do you think is your parents' expectation about your achievement in studies?

Translator:	About the progress of your studies progress what's your parents' opinion? How do they feel?
Tony:	They feel that I'm average.
Translator:	They feel that... my standing is an average.
Interviewer:	What do you think your parents would like you to do when you finish secondary school?
Tony:	I don't know.
Interviewer:	In what ways do your parents help in making decision about your maths studies?
Translator:	For mathematics studies, did your parents help in making any decision?
Tony:	They buy me books and all.
Translator:	They help me in purchasing the books.

Interview transcript of Parent : Jane

Interviewer:	What is your name?
Jane:	Jane
Interviewer:	How many children do you have?
Jane:	Two.
Interviewer:	What do you do for living?
Translator:	What's your job?
Jane:	My husband is working for a living.
Translator:	What's your husband?
Jane:	My husband is an electrician in Electricity Board.
Translator:	My husband is working as an electrician.
Interviewer:	How much are you involved with your child's schooling?
Translator:	How much do you involve in your children's schooling?
Jane:	I help them the best I could.
Interviewer:	What helps do you do?
Jane:	I wash their dresses, make food for them, and teach them a little bit as I could.
Translator:	I use to provide all the necessary help such as washing clothes and providing all their needs. Apart from that to some extent I use to help them in their studies.
Interviewer:	How do you help your child with his studies?
Translator:	How do you help your children's with their studies?

Jane:	I advice them to study well. I use to monitor them.
Translator:	I use to advice them to study well and also I use to monitor their progress.
Interviewer:	How often do you check his homework?
Translator:	How often do you check his homework?
Jane:	I use to check their homework.
Interviewer:	Is it one day per week or anything like that?
Jane:	I use to check it once in a week.
Translator:	I use to check their homework once in a week or once in few days.
Interviewer:	How much are you involved with your child's mathematics learning?
Translator:	How much are you involved with your child's studies, particularly in maths?
Jane:	I've arranged tuition for maths.
Translator:	We have provided tuition for our children in maths.
Interviewer:	Do you check the assessment result of your child in mathematics?
Translator:	Do you check your son's mathematics reports card?
Jane:	Yes, I use to check.
Interviewer:	Why?
Translator:	Do you check your child's maths marks particularly?
Jane:	Yes, because maths is important for their future studies.
Translator:	I use to check maths marks because it is important for their future studies.
Interviewer:	What is your opinion about your child's achievement in maths?
Translator:	What's your opinion about your son's maths performance?

Jane:	I think he needs to improve a little bit.
Translator:	I feel that he can improve some more.
Interviewer:	How often do you monitor the time your child spends on maths?
Translator:	Do you watch your son spending time to learn maths?
Jane:	Yes, I do.
Translator:	Yes, I use to watch.
Interviewer:	How do you monitor the time your child spends on activities other than studies like watching TV, playing games, socializing et cetera?
Translator:	Other than studies of your son, watching TV, chatting with friends, other activities, playing games et cetera do you watch the time spend by your son?
Jane:	Yes, I do.
Interviewer:	Do you watch how much time they spend for these activities?
Jane:	Yes, I use to tell.
Interviewer:	Do you warn your kids to watch TV for a particular time? Is there any time table for that?
Jane:	Yes. They are allowed a specific time for that.
Translator:	I use to watch them. We use to provide them timing for those activities.
Interviewer:	How often do you consult your child's teacher about his mathematics performance?
Translator:	Do you consult your son's maths teacher about his performance in maths?
Jane:	Sure.

Interviewer:	How often?Is it monthly or...
Jane:	When I go to school I use to ask.
Interviewer:	How often, is it monthly?
Jane:	Yes, once in a month.
Interviewer:	You go once in a month?
Jane:	Two months.
Translator:	Once in two months I use to meet the teacher.
Interviewer:	What is your view about working hard in studies particularly in maths?
Translator:	Do you believe your children could improve in maths if they study hard?
Jane:	Sure. If they work hard they could improve.
Translator:	Surely I believe that if my son is working hard in maths he can do better.
Interviewer:	What is your. ... worst subject in school?
Translator:	During your school days what was your worst subject?
Jane:	It's maths.
Translator:	Maths was the most. .... the worst subject.
Interviewer:	How do you help your child to make decision about his studies?
Translator:	Do you advice your son to make particular decisions about his future studies?
Jane:	Yes, I use to say, just concentrate on studies now, in future he could do according to his decision.
Translator:	I use to advice them that currently he has to study well. In future he can do depending upon his studies.
Interviewer:	What is your expectation about your child's achievement in school?
Translator:	What s your expectation? I mean, do you believe your son should improve more?
Jane:	I wish he should improve more.
Translator:	I wish that he will be able to do very well in his studies.

Interviewer: What do you want your child to do when he finish his secondary school?

Translator: After Year-12, what do you think your son should study?

Jane: It depends on him. It will be his choice to select his interested topics.

Translator: It depends upon his interest when he completes his school studies.

Interviewer: Why?

Translator: Why are you making him select the choice?

Jane: It's up to him, because he should learn what he is interested in. It's not our interest, it's their interests.

Translator: It will bring good results if my son is selecting his career or studies as per his interest rather than imposing my interest.

Interviewer: How do you encourage your child in his studies?

Translator: How do you encourage your son educationally? Do you advice him, do you scold him or anything like that?

Jane: My son feels that I'm over advising him, which eventually means that I'm advising a lot.

Interview transcript of Student: Mary

Interviewer:	What is your name?
Mary:	Mary
Interviewer:	How old are you?
Mary:	16.
Interviewer:	How many siblings do you have?
Mary:	I'm single.
Interviewer:	Who helps you with your study?
Mary:	Nobody helps me.
Interviewer:	Do you think mathematics is important in your future work?
Mary:	Yes.
Interviewer:	In what ways?
Mary:	It helps me doing... doing my everyday life. And also for my study purpose they are important.
Interviewer:	Why do you think it's important?
Mary:	I think... I don't know. I love maths. I love... I think it's important because it's useful for us.
Interviewer:	How do you rate yourself as a mathematics student?
Mary:	Good. I can score above 80 in maths.
Interviewer:	How do you feel about it when you rate yourself?
Mary:	I'm confident that I can score it.
Interviewer:	What's your worst subject in the school?
Mary:	History.
Interviewer:	How do you feel when taking a mathematics test?
Mary:	I'm not at all nervous while writing the exam. I feel quite normal. I'm not...

Interviewer:	Which mathematics course are you studying now? That means what all topics you're taking in Year-11?
Mary:	Arithmetic evaluation, trigonometry is there, sequence and series, linear equations.
Interviewer:	Okay. And why did you choose this course, are you compelled to do all the topics in the text?
Mary:	Yes, yeah.
Interviewer:	In what ways if any are your parents involved in your mathematics learning?
Mary:	No, in what basis...
Interviewer:	If any?
Mary:	No.
Interviewer:	Whether they are involved or not?
Mary:	Our chapters... in some chapters like...
Interviewer:	Or else you can say in particular topics...
Mary:	Sets and series.
Interviewer:	Okay.
Mary:	They are also helping.
Interviewer:	Okay. And other than helping with your particular topic, is there any help from your parents' side in arranging ...
Mary:	Yes, yes.
Interviewer:	extra helps from outside or ...
Mary:	They have arranged maths tuition and all. That's it.
Interviewer:	How often do your parents check your homework?
Mary:	No, they won't check.
Interviewer:	Who helps you with your maths book ... who helps you with your maths book?
Mary:	I've tuition, my school teacher and my friends.

Interviewer:	Do your parents monitor the time you spend watching TV?
Mary:	Yes.
Interviewer:	Why?
Mary:	They want me to study when I'm watching TV.
Interviewer:	How they monitor the time you spend on watching TV?
Mary:	They ask me... they will... they say I don't watch it for more than two hours.
Interviewer:	Is it everyday or...
Mary:	No.
Interviewer	...maybe...
Mary:	No, I have no time to watch TV...
Interviewer:	During weekend or...
Mary:	During Saturday and Sunday.
Interviewer:	What is your parents' opinion about your achievement in mathematics?
Mary:	Good.
Interviewer:	What do they say about the marks you scored in maths or... are they happy with it?
Mary:	Yeah, they are happy.
Interviewer:	Do your parents monitor the time you spend on maths?
Mary:	No.
Interviewer:	Can you say why?
Mary:	No, they want me to study.
Interviewer:	What do you want to do when you finish secondary school? That means Year-12.
Mary:	I'm going to write entrance and if I'm getting I'll go to... for medicine.
Interviewer:	Can you explain why you choose that profession?
Mary:	I love... I love that profession...
Interviewer:	Why?There maybe a reason because you're choosing medicine, there will be something in your mind.
Mary:	I love science group.

Interviewer:	Okay.
Mary:	And I...
Interviewer:	So because of love of science you're learning?
Mary:	Yes.
Interviewer:	Okay. What is your view about working hard in studies, particularly in maths?
Mary:	Yeah, I'm ready to work hard in maths, and I don't like...
Interviewer:	Well, the thing is... my question is working hard in studies... that are overall studies, whether the students have to work hard or not?
Mary:	They have to work hard. We have to work hard.
Interviewer:	Why?
Mary:	Because for achieving something they have to work hard.
Interviewer:	What do you think is your parents' expectation about your achievement in school?
Mary:	They want me to score... A and A plus.
Interviewer:	What do you think your parents would like you to do when you finish secondary school?
Mary:	They want me to complete... they want me to pass the entrance and they want me to join... and go for medicine.
Interviewer:	Can you say why they want you to do medicine? Because you're choosing medicine you love science...
Mary:	Yeah.
Interviewer:	... and why you're thinking they are also expecting you to do medicine?
Mary:	I want me to become a doctor.

Interviewer:	Can you say why?
Mary:	It is my mother. She loves... she says that she... she wanted to become a doctor, but she can't do that, she can't do it, but she is asking me, I'm not telling that she is...
Interviewer:	I know...
Mary:	... not forcing me to do it.
Interviewer:	... I understand what you're explaining.
Mary:	She wanted to become a doctor, but she can't...
Interviewer:	They are not forcing you.
Mary:	Yes.
Interviewer:	But both your parents and you want to do medicine. In what ways your parents help in... help you in making decisions about your maths studies? Whether you have to do this... you have to do all these subjects or how to study, whether they are giving you any instruction?
Mary:	They give me... yeah, they collect books for me, for maths and all... and for all subjects they collect the book from their friends and all, and that's...
Interviewer:	Thank you so much.

Interview transcript of Parent: Lizy

Interviewer:	What is your name?
Lizy:	Lizy
Interviewer:	How many children do you have?
Lizy:	One.
Interviewer:	What do you do for living?
Translator:	What's your job?
Lizy:	I'm working as a clerk in Civil Supplies.
Translator:	I'm working as a clerk in the Civil Supplies Department.
Interviewer:	How much are you involved with your child's schooling?
Translator:	How much are you involved with your child's schooling?
Lizy:	I am involved in almost everything.
Translator:	I'm involved in all the activities of my child in the school.
Interviewer:	How do you help your child with her studies?
Translator:	How do you help your child with her studies?
Lizy:	If they have any doubts, I could teach her science subjects, but for maths I'm not that good.
Translator:	I used to help her with her science subjects. I'm not so strong in maths, but I use to help in other subjects.
Interviewer:	How often do you check her homework?
Translator:	How often do you check her homework?
Lizy:	I monitor that daily.
Translator:	I use to monitor her homework daily.
Interviewer:	How much are you involved with your child's mathematics learning?
Translator:	How much are you involved in your daughter's mathematics learning?
Lizy:	Maths, she used to study well. As I am not that good at maths I can't involve much in that. But I've arranged tuition for her.

Translator:	I can't help her much in mathematics. Of course I use to help her by providing her tuition and help in other subjects.
Interviewer:	Do you check the assessment result of your child in mathematics?
Translator:	Do you check your daughter's maths assessment?
Lizy:	Yes, I do. She gets good marks in maths.
Translator:	I use to check her marks in mathematics. Usually she gets good marks in maths.
Interviewer:	Why do you check her results on maths?
Translator:	Why do you check your maths mark specifically?
Lizy:	Maths is an important subject. It's very useful in our day to day life. Problem solving mentality comes with maths. So I feel that maths is very important. I also try to make her understand how important maths is in our life.
Translator:	We give importance to maths because maths is important for her day to day life. Also by solving mathematical problems her problem solving skills also will improve. And also we have made our daughter to understand about the importance of maths.
Interviewer:	What is your opinion about your child's achievement in mathematics?
Translator:	What's your opinion about daughter's achievement in maths?
Lizy:	She studies maths well. Usually she scores good marks at maths. I'm satisfied.
Translator:	I'm happy with my daughter's performance in mathematics. She is scoring very high marks and she is doing very well in mathematics.
Interviewer:	How often do you monitor the time your child spends on mathematics?
Translator:	How often do you monitor the time your daughter spends on mathematics?

Lizy:	Yes.
Translator:	Do you tell her to learn maths thoroughly?
Lizy:	Yes.
Translator:	She is devoting more time for her mathematics studies.
Interviewer:	How do you monitor the time your child spends on activities other than studies like watching TV, playing games, socializing et cetera?
Translator:	Other than studies, in other activities do you monitor the time your daughter spends?
Lizy:	Yes. I allow her time for other activities like playing, watching TV et cetera.
Interviewer:	How do you allow your daughter to socialize with their friends?
Lizy:	She has a group of good friends. She uses to meet her friends.
Translator:	I use to permit her to watch TV, but on a specified time slot. I use to monitor how she is spending her time on TV. Apart from that we also permit them to have fellowship with her friends. She has some group of friends.
Lizy:	She also has contacts with her old friends, one of her old friend is in Kottayam, but she has contacts with them too.
Translator:	Also my daughter use to have contact with her old friends. She uses to call them over phone. Some of her friends moved to another town. She is also maintaining her contact with them also.We use to permit such contacts.
Interviewer:	How often do you consult your child's teacher about her mathematics performance?
Translator:	How often do you consult your daughter's teacher about her mathematics performance?
Lizy:	I use to go to school once in a month.
Translator:	I use to go to school once in a month.

Interviewer:	What is your view about working hard in studies particularly in maths?
Translator:	What's your opinion about your daughter in maths, does she need to work hard to achieve her goals?
Lizy:	She must hard work. If she works hard then only she could achieve good marks.
Translator:	I feel that hard work is very important to achieve good results in studies.
Interviewer:	Which was your worst subject in school?
Translator:	During your school days what was your worst subject?
Lizy:	Maths was difficult for me, it was tough. So when my daughter does well in maths I feel so happy. I love her watch studying maths.
Translator:	One of the subjects which I found difficult was mathematics even though I never disliked it. But I'm happy to see that my daughter is doing very well in maths.
Interviewer:	What is your expectation about your child's achievement in school?
Translator:	What's your expectation about your daughter's achievement?
Lizy:	She must work hard more. She must try to get more marks.
Translator:	I want my daughter to work hard and to improve her scores further.
Interviewer:	What do you want your child to do when she finish secondary school?
Translator:	After secondary school, what do you want your child to proceed further?

Lizy:	I don't have any particular desire. She wishes to join medicine. I support that. When I was a student I too wished to become a doctor, but I couldn't. I don't compel her to become such and such, but from her earlier days I managed to generate an ambition in her. So now she is interested in going to medicine. Is she take maths as her main subject, it's okay for me, if its science... that's her interest.
Translator:	Specifically I don't have any particular opinion. But my daughter wants to do medicine. We support that. When I was doing my studies I was interested in doing medicine. I didn't get an opportunity for doing that. But I will be happy if my daughter is able to do medicine.
Interviewer:	How do you encourage your child in her studies?
Translator:	How do you encourage your daughter in her studies, in what ways?
Lizy:	Like I said earlier, I use to collect all her details. I don't disturb while she is studying. I'm an employee, but I don't disturb her anyway. I collect all the materials needed for her study. We used to advice her about her future. We tell her she should have her own earning. We make her understand the value of being on her own foot.
Translator:	We use to provide all the support materials that are required for the studies. Generally we don't disturb her in her studies. We generally don't permit her to do any household works because we want her to completely devote herself to the studies. And whatever support she needs we use to provide her.
Interviewer:	Thank you.

Interview transcript of Student: Hema

Interviewer:	What is your name?
Hema:	My name is Hema.
Interviewer:	How old are you?
Hema:	I'm 16.
Interviewer:	How many siblings do you have?
Hema:	One.
Interviewer:	Brother or sister?
Hema:	Brother.
Interviewer:	Who helps you with your study?
Hema:	My mother.
Interviewer:	Do you think mathematics is important in your future work?
Hema:	I think.
Interviewer:	In what ways?
Hema:	I like to do maths.It's interesting.
Interviewer:	How it helps you in future?
Hema:	I think every... everything that we do will need maths and will help.
Interviewer:	Do you think... sorry, how do you rate yourself as a mathematics student?
Hema:	An average.
Interviewer:	How do you feel about your own rating?
Hema:	If I study then I can write it well.
Interviewer:	What is your worst subject in school?
Hema:	Physics.

Interviewer:	Can you say why?
Hema:	I don't understand anything.
Interviewer:	Is it because you feel a bit difficult, you find it difficult with maths...
Hema:	Yeah, I find it difficult.
Interviewer:	Is it because of the maths or...
Hema:	No. Not at all... not the maths, but the way of teaching.
Interviewer:	How do you feel when taking a mathematics test?
Hema:	I feel it is easy.
Interviewer:	I mean, in your mind, how do you feel in mind?
Hema:	It's free...
Interviewer:	You're not tensed?
Hema:	No, no tension.
Interviewer:	Okay. Which... sorry, in what ways if any are your parents involved in your mathematics learning? Whether your parents help you in doing maths or...
Hema:	Yeah. They help me in doing... my mother help me in doing that's still 8th standard.
Interviewer:	And what's happening now?
Hema:	Now I study.
Interviewer:	By yourself?
Hema:	Yeah.
Interviewer:	Do you've any tuition or...
Hema:	Yeah, I've tuition.
Interviewer:	How often do your parents check your homework?
Hema:	No.
Interviewer:	Who helps you with your maths work?
Hema:	Maths work, mainly its friends and teachers.

Interviewer:	What about your tuition maths?
Hema:	Yeah, it includes teachers...
Interviewer:	Do your parents monitor the time you spend watching TV?
Hema:	Yeah.
Interviewer:	Why?
Hema:	Because I spend more time watching TV.
Interviewer:	So how do they monitor the time you spend on watching TV? Whether they will switch it off or whether they ask you to go and...
Hema:	They ask me to switch it off.
Interviewer:	What is your parents' opinion about your achievement in maths?
Hema:	I think it's a good opinion.
Interviewer:	Whether they are happy with what do you achieve or whether they want you to do better?
Hema:	When I got a good mark then they are happy. And when I got low mark they will beat me because I didn't study everything.
Interviewer:	Do your parents monitor the time you spend on maths?
Hema:	Yeah. All the subjects...
Interviewer:	Why... why they are checking the time you spend on studies?
Hema:	I spend time for studies only in the time of examination, so they check that I'm studying or not.
Interviewer:	What do you want to do when you finish secondary school? That means after Year-12.
Hema:	After 12th I like to write the entrance exam.

Interviewer:	Okay.
Hema:	If I didn't get entrance, then...
Interviewer:	Which ones?
Hema:	Both engineering and medicine.
Interviewer:	Can you say why? Why you're choosing either engineering or medicine?
Hema:	I like... I like computer engineering very much. So I'll write that.
Interviewer:	Okay.
Hema:	And I will try medicine also.
Interviewer:	Then why you are choosing medicine?
Hema:	Because I like to help others.
Interviewer:	What is your view about working hard in studies, particularly in maths? What is your view, whether the students have to work hard or not?
Hema:	The students have to work hard. But they should not get tension for studying. Mainly the students are... they are more tensed for writing exams and... working hard and if they got the question paper they can't write anything. And that's...
Interviewer:	What do you think is your parents' expectation about your achievement in school? Expectation that means in future, whether they've a... they've something in their mind about how much you have to achieve or...
Hema:	I think they need... they are saying that I've to... for me...
Interviewer:	Okay.
Hema:	In my case I've to achieve in high position. So I've to make my life safe.
Interviewer:	What do you think your parents would like you to do when you finish Year-12?

Hema:	They will really ask me to get a job, get a government job.
Interviewer:	Can you say why?
Hema:	Because nowadays medicine and engineering, they are not at all that much valuable, and if we get a government job then we can... we can... it will be a permanent one.
Interviewer:	Okay.
Hema:	They will be not lost [Phone rings] suddenly.
Interviewer:	I'm going further from your point. Why you're saying medicine and engineering are not at all valuable?
Hema:	I think nowadays they are... they're easily available. I think... I think so.
Interviewer:	In what ways do your parents help you in making decisions about your maths study... how long you've to study or how...
Hema:	No, they don't give me any timing to... if we're studying for five minutes we have to study that exactly or completely or thoroughly.
Interviewer:	Okay.
Hema:	They are not giving any timing for that.
Interviewer:	Okay, thank you.

Interview transcript of Parent: Rani

Interviewer:	What is your name?
Rani:	My name is Rani.
Interviewer:	How many children do you have?
Rani:	Two.
Interviewer:	What do you do for living?
Translator:	What's your job?
Rani:	I'm a housewife. We live with my husband's income.
Translator:	My husband is employed. My husband is working in Gulf.
Interviewer:	How much are you involved with your child's schooling?
Translator:	How much are you involved with your daughter's studies?
Rani:	I watch all activities of my child. During exam times we monitor her a lot. I used to check her homework before, but nowadays I don't check her homework daily. I use to tell her to study maths thoroughly. I use to go to school and talk with the teachers.
Translator:	I'm watching all activities of my daughter's studies. During exam times I use to monitor their studies and also check their homework. And also I will.... I use to go to school and enquire teachers about her progress.
Interviewer:	How often do you check her homework?
Translator:	How often do you check your daughter's homework, is it once in a week?
Rani:	I don't check daily homework. She usually does her homework. So I don't check her homework. I observe her doing projects and homework well.

Translator:	I'm not checking their homework daily, but I know that they are doing their homework on time. But if there are some special project assignments I use to watch they are doing in time.
Interviewer:	How much are you involved with your child's mathematics learning?
Translator:	How much are you involved with your daughter's mathematics learning?
Rani:	Till seventh standard maths was seen as a difficult subject, but after that she scored very high marks in maths. Hard working, tuition, she has tuition alone in maths, so she had advantage of that. For her, maths is one of her easiest subjects when compared to others. Maths is important. She is interested in engineering, so for that maths is very important. For a government job like bank test maths is important. In our day to day life maths is important.
Translator:	Up to Year-7 maths was a difficult subject for my daughter, but after Year-7 she started getting good marks in mathematics. That maybe because of ..since we are providing tuition for her in mathematics. And moreover that mathematics is an important subject. She is having willingness to study engineering after ..... when she completes year 12, and mathematics is an important subject. If at all she wants to go for some government jobs like bank jobs and other organizations she need very good knowledge of mathematics.
Interviewer:	What is your opinion about your child's achievement in maths? Whether you are happy or...

Translator:	What's your opinion about your daughter's maths achievement? Are you happy?
Rani:	Maths was difficult for her at one time, but after learning it well, she liked it very well. She got good marks in 10th standard in maths. For engineering, there are a lot of people who finished engineering and seeking for a job, some are jobless. And engineering is expensive too. So after we spend a lot and if she didn't get a job, so I'm asking her to attend bank test and try to get a government job. So I'm happy with her achievement in maths.
Translator:	I'm happy about her achievement in mathematics. I'm happy because earlier she was finding it difficult to study mathematics. Later on mathematics became much easier for her. Anyhow for engineering she needs mathematics, but of course engineering .....now there are many students who are completing engineering and still unemployed. But it is better to get through a bank test and get some government job.
Interviewer:	How often do you monitor the time your child spends on maths?
Translator:	How often do you observe the time your child spends on maths?
Rani:	I think since the last five-six months, she was not doing well at maths. Till then maths was the subject she spend most of her time. I think she is not doing that well nowadays in maths.
Translator:	Since past five months I feel that she is not spending enough time in mathematics. But before that she uses to do a lot of problems and spend more time in solving mathematical problems. Then for her year 10 exams she solved many problems, and I use to monitor her mathematics studies.

Interviewer:	How do you monitor your child spends on activities other than studies like watching TV, socializing et cetera?
Translator:	Other than studies, in other activities do you monitor the time your daughter spends?
Rani:	Time she uses at home, right?
Interviewer:	Yes.
Rani:	At home she loves to watch TV. Whenever I take my eyes off her she watches TV. When I'm at home I watch her all the time. I have never asked her not to see TV. But I've said there should be a time. She should select which program she should see. That's all. I've never asked her not to watch TV.
Interviewer:	What about friends?
Rani:	Friends, I know all her friends. They calls her over phone, have contacts. She has good friends. I warn her she should tell me details about all her friends. For celebrations and parties, we invite all friends.
Translator:	My daughter is very much interested in watching TV, but I use to monitor that she is not spending too much time on TV. Regarding her social activity I'm not putting any restriction, but the only thing is I want her to watch selected programs in TV as well as .....some selected friendship. The only thing is I just want to know about her friends ..... to know more about them.
Interviewer:	What is your view about working hard in studies particularly in maths?
Translator:	What's your opinion about hard working in studies, particularly in mathematics?

Rani:	Hard working is required. We should not be lazy. We could achieve only through hard work. For maths, the more we do the more we learn. By that I don't mean they should learn maths from morning till evening. Hard working is necessary.
Translator:	Hard working is very important to achieve good results in academic field. Regarding mathematics if you solve more problems you can do well in mathematics. But I'm not telling that one should do mathematics problem from morning to noon or so, but what I'm telling is one should put hard work to achieve good results.
Interviewer:	Which was your worst subject at school?
Translator:	During your study days, what was your difficult subject?
Rani:	It was maths.
Translator:	For me maths was the difficult subject.
Interviewer:	What is your expectation about your child's achievement in school?
Translator:	What is your expectation about your daughter's achievement in school?
Rani:	She have to study well, it's not like you must get school first or rank, but must study well and achieve good marks. She should get good marks for further admission in high studies. Nowadays students achieve 80% and above. So she should also work hard. She should study well to get admission for further studies.

Translator:	I would like my daughter to score high marks, but I'm not asking her to get the first rank or second rank and like that. But anyway I will be happy if she is able to get sufficient marks to get admission into the courses of her choice.
Interviewer:	Do you help your child to make decision about her studies?
Translator:	How do you help your daughter to make decision about her studies?
Rani:	For all subjects, for engineering or medicine or any government job, I'm giving her all details about that. What's the course length of engineering, how is B.Ed., engineering and medicine.... ..she asks me if I get admission for medicine would you allow me to study that, then I would say if you could get admission on government college you can go, because it's so expensive to teach medicine. I can't teach her by taking loan or anything. So whatever is good, a good government job would be better. But if she gets engineering we'd let her go. But we don't like to take loans to teach her. We use to tell her details about all subjects.
Translator:	I use to provide her with all the information regarding her higher studies. I use to explain to her about engineering courses, medical courses and other government jobs. It is up to her to write .....to get through the entrance examination whether it is engineering or medicine. But I can provide them with all the necessary support such as providing them entrance coaching and other things. But I don't want them. ....I don't want to get them an admission by providing donation with the help of a loan because I don't want to make any further financial obligations.
Interviewer:	Thank you.

Interview transcript of Student: Honey

Interviewer:	What is your name?
Honey:	Honey
Interviewer:	How old are you?
Honey:	13.
Interviewer:	How many siblings do you have? Any brothers or sisters?
Honey:	No.
Interviewer:	Who helps you with your study?
Honey:	Mother.
Interviewer:	Do you think mathematics is important in your future work?
Honey:	Yes.
Interviewer:	In what ways?
Translator:	You can say in Malayalam.
Honey:	Maths is an important subject. If we study maths well, it's good.
Translator:	Maths is an important subject, if you are doing well in maths that is good.
Interviewer:	How do you rate yourself as a mathematics student?
Translator:	How do you rate your mathematics performance in your class? Is it medium or average or high?
Honey:	Not high, it's medium.
Translator:	Not high, medium.
Interviewer:	How do you feel about your own rate? When you say you're medium...
Translator:	What do you feel, do you feel is it okay; are you satisfied or do you think you need to improve?
Honey:	I'm not satisfied.
Translator:	I'm not satisfied.
Interviewer:	Why?
Honey:	I got to do well in maths.

Interviewer:	I'll come to that question later. What is your worst subject in school?
Honey:	Chemistry.
Interviewer:	How do you feel when taking a mathematics test?
Honey:	Difficult.
Interviewer:	Is it difficult because you don't understand the subject or because you get tensed?
Honey:	I get tensed.
Interviewer:	Which... in what ways if any are your parents involved in your mathematics learning?
Translator:	Do your parents help you in your mathematics studies?
Honey:	No.
Interviewer:	How often do your parents check your homework?
Translator:	Do your parents' check your homework regularly?
Honey:	They don't check my homework.
Translator:	Not checking, do they ask did you do the homework?
Honey:	Yes, they do.
Translator:	They won't check my homework, but they will monitor whether I'm doing my homework.
Interviewer:	Who helps you with your maths work?
Honey:	Tuition sir.
Translator:	My tuition sir is helping me.
Interviewer:	Do your parents monitor the time you spend watching TV?
Honey:	Yes.

Interviewer:	Why? Can you say why they're checking the time you spend watching TV?
Translator:	Why do they say you should not watch TV, why do they restrict those things?
Honey:	Because studying is very important, so...
Interviewer:	How do they monitor? They ask you to watch it for half an hour or...
Honey:	No, always telling to study. Don't watch TV all time.
Interviewer:	What is your parents' opinion about your achievement in mathematics?
Translator:	What is your parents' opinion about your marks you score in mathematics?
Honey:	I don't usually get good marks in maths. Even if I study well and go to exam, I forget the answers.I don't know why it's like that, maybe due to tension.
Translator:	Mostly I won't get good marks in mathematics even though I study well. But I use to forget whatever I've studied during my exams. I don't know the reason.
Interviewer:	What do you want to do when you finish second school? That means after finishing Year-12.
Translator:	After your Year-12, what is your ambition?
Honey:	My ambition is to become a doctor. So maths is not... I think maths is not important in... to become a doctor.
Interviewer:	Can you say why you choose that profession? Why you want to become a doctor? There maybe a reason behind choosing that profession.
Honey:	No reason.
Interviewer:	No reason?

Honey: Since... when I was young I used to tell... once my mother was not well, during that... since that time I used to tell that I want to become a doctor, but gradually that became my ambition.

Translator: To be honest, in the past when my mom was sick I used to tell I would become a doctor. And so gradually that became my ambition.

Interviewer: What is your view about working hard in studies, particularly in maths?

Translator: What is your opinion about hard working, particularly in mathematics?

Honey: Even though I studied well, I don't achieve well in maths. For example, for this exam even though I studied well I couldn't achieve well. When I see the maths question paper, I feel tensed and my mind goes blank.

Translator: I think that even though I study very well I feel that there is no use in that because when I sit in the mathematics exam I feel everything is blank, I'm not able to do well in maths.

Interviewer: What do you think is your parents' expectation about your achievement in mathematics?

Translator: What do you think your parents' feel when you see your maths marks and grade, and reports and such that?

Honey: They are sad.

Interviewer: They are not...

Honey: They are not satisfied.

Translator: They are not happy. They are not satisfied.

Interviewer: What do you think your parents would like you to do when you finish secondary school?

Translator: What do you think your parents' like you to learn after finishing secondary school?

Honey:	My father use to say he doesn't have any specific desires. He says I should get a good job, I need to stand on my own feet, that' all.
Translator:	My father doesn't impose any specific target, but he used to advice me that I should get a good job and stand on my own foot.
Interviewer:	In what ways do your parents help you in making decisions about your maths studies?
Translator:	In what ways do your parents help you in making decisions about your maths studies?I mean, in future you should do like maths like this or anything like that, any help from your parents?
Honey:	I haven't taken any decision like that. I don't take decisions like that.
Translator:	So far there was no chance that we should take any major decisions like that.
Interviewer:	Okay.

Interview transcript of Parent: Mathew

Interviewer:	What is your name?
Mathew:	Mathew
Interviewer:	How many children do you have?
Mathew:	One.
Interviewer:	What do you do for a living?
Translator:	What's your job?
Mathew:	Government servant.
Translator:	I'm a government servant.
Interviewer:	How much are you involved with your child's schooling?
Translator:	How much are you involved with your child's studies?
Mathew:	Usually I don't, because I don't get time and moreover I can't teach the topics.
Translator:	Generally I don't get much time to teach my children. And moreover that I'm not capable of teaching my children therefore I have a limited involvement.
Interviewer:	How do you help your child with her studies?
Translator:	How do you help your child with her studies?
Mathew:	I teach her as I could, like social studies, which I have knowledge of, only which when she asks for. Otherwise I don't do that. Is she asks me to teach, I do as I could.
Translator:	I use to teach her the subjects which I can handle, usually social studies. Whenever my daughter needs help I use to help her.

Interviewer:	How often do you check her homework?
Translator:	Do you check your daughter's homework often?
Mathew:	No.
Translator:	No, I don't check her homework.
Interviewer:	How do you help your child with the maths studies?
Translator:	Do you check your daughter's maths homework?
Mathew:	I don't know, so I don't check.
Translator:	I'm unable to teach her maths therefore I don't check her maths homework.
Interviewer:	Do you check the assessment result of your child in mathematics?
Translator:	Do you check your daughter's progress report and marks?
Mathew:	Yes, I do.
Translator:	I use to check her marks.
Interviewer:	What's your opinion about your child's achievement in mathematics?
Translator:	What's your opinion about your daughter's achievement in mathematics?
Mathew:	For maths, she is not that good. So I've a little tension about it, but I can't teach her maths. So I've arranged tuition for maths and tell her to study well on maths.
Translator:	Her marks in mathematics are low and I'm a little bit worried about that. I can't teach her mathematics, but I have given her tuition to help improve her mathematics studies.
Interviewer:	How do you monitor the time your child spends on activities other than studies like watching TV, playing games or socializing et cetera?

Translator:	Other than studies, other activities like watching TV, spending time with friends, playing games do you monitor the time your daughter spends?
Mathew:	Monitor time?
Translator:	How much time she spend TV and spending time with friends and playing games et cetera?
Mathew:	She don't play with friends, she don't have any friends here. She used to play badminton. I'm interested in those, but she is not interested in those. Usually we don't get time for all these things. TV, she doesn't watch too long.
Translator:	Generally my daughter doesn't have more friends therefore there is no worry about that. Apart from that my daughter is not interested in playing many games. She used to play badminton sometime back for a few days. Regarding TV my daughter is not interested in spending more time in TV. I don't put any restriction, but she does not watch TV for that long.
Interviewer:	How often do you consult your child's teacher about her mathematics performance?
Translator:	How often do you consult your daughter's teacher about her mathematics performance?
Mathew:	When she gets the progress report I use to go there and talk with teachers.
Interviewer:	How often is it? Is it like one month?
Mathew:	Not one month, three months.
Translator:	Once in three months I use to meet her class teacher and ask about her performance.
Interviewer:	What is your view about working hard in studies, particularly in maths?

Translator:	What is your opinion about working hard in studies, particularly in maths?
Mathew:	To my knowledge, maths needs hard work. For maths, children should work hard. They should repeatedly do them to improve.
Interviewer:	Do you think students should work hard in all subjects...
Mathew:	More than any other subjects, I think maths needs hard working.
Translator:	I feel that working hard is very important for mathematics. And specifically compared with other subjects mathematics requires hard work.
Interviewer:	Which was your worst subject in school?
Translator:	During your school days, what was your difficult subject?
Mathew:	It was maths.
Translator:	Maths was my worst subject.
Interviewer:	What is your expectation about your child's achievement in school?
Translator:	What is your expectation about your daughter's achievement in school?
Mathew:	I wish she should study very well. There is no particular aim, like becoming an engineer, or doctor , I don't think so. What she is interested she should study, what she could do. Not all people can get become a collector or become an police officer, so according to her interest she should study. It's not like she should not study anything. She should study according to her interest. That's my wish.

Translator:	Generally I don't impose a specific target for my daughter. I don't say that she should become an engineer or a doctor or an administrative officer, but depending upon her capability she should be able to do well to achieve according to her capabilities.
Interviewer:	How do you encourage your child in her studies?
Translator:	How do you encourage your daughter in her studies?
Mathew:	Particularly... I don't... it's not me who actually looks all her subjects, it's her mother. So she helps her most. Helps from my side are less. I take her to tuition, buys books for her. Usually I can't handle these subjects, so I don't involve much in it. As I said earlier, I help her in social studies only if she asks me.
Translator:	Generally I don't get involved much in my daughter's education, usually it is her mother who advice her regarding her studies. I use to help her in all ways I can like purchasing the books and taking her to tuition and so on. And with my limited capabilities I use to teach her social studies and other subjects which I'm capable of teaching her.

Appendix L: Overall Item Fit Statistics- Students

Entry	Items	Short name used	IN.MSQ	IN.ZSTD	OUT.MSQ	OUT.ZSTD
1	I like learning maths more than any other subject	sattitude 1	0.7072	-2.7693	0.7521	-2.1092
2	Maths is the easiest subject at school	sattitude 3	0.9418	-0.4891	0.9474	-0.4091
3	Having good mathematics skills important for a well rounded education	sattitude 4	0.8511	-0.9591	0.8337	-0.9992
4	I do not enjoy learning maths	sattitude 5	1.2548	1.9513	1.368	2.4814
5	It would make me happy to be recognised as an excellent student in mathematics	sattitude 6	1.4367	2.0914	1.2146	1.0912
6	I'd proud to be the outstanding student in mathematics	sattitude 7	1.5638	3.3116	1.5412	2.9415
7	Being first in a mathematics competition would make me pleased	sattitude 8	1.1686	1.0512	1.1599	0.9412
8	If I had good grades in maths, I would try to hide it	sattitude 9	1.2172	1.2112	1.2547	1.3413
9	Generally I feel secure while attempting maths	sconfidence 1	0.6153	-3.8994	0.6	-3.7894
10	I am sure I could do advanced mathematics	sconfidence 2	0.6657	-3.3993	0.6514	-3.3493
11	I think I can handle difficult mathematics	sconfidence 3	0.6678	-3.3993	0.6628	-3.2993
12	I am sure I can get good grades in maths	sconfidence 4	0.8621	-0.9391	0.8328	-1.0592
13	I have a lot of self-confidence when it comes to mathematics learning	sconfidence 5	0.7821	-1.9292	0.7316	-2.2293
14	I don't think I can do advanced maths	sconfidence 6	0.8392	-1.4692	0.8572	-1.1991
15	I am not the type of person to do well in mathematics	sconfidence 7	0.9435	-0.4491	0.8919	-0.8391
16	Maths has been my worst subject	sconfidence 8	1.0126	0.131	0.929	-0.3991
17	For some reason even though I study hard, mathematics is difficult for me	sconfidence 9	1.0146	0.171	1.0719	0.6511
18	I am not good at maths	sconfidence 10	0.8816	-0.9991	0.8534	-1.1491
19	I'll need mathematics for my future career	susefulness 1	1.2672	1.9813	1.2186	1.5112
20	Studying mathematics will help me to earn a living	susefulness 2	1.0152	0.161	0.9386	-0.3991
21	I will use mathematics in many ways as an adult	susefulness 3	0.8344	-1.4992	0.8398	-1.3392
22	Mathematics ia a worthwhile and necessary subject	susefulness 4	0.8929	-0.6191	0.8522	-0.8291
23	I'll need a firm mastery of mathematics for my future career	susefulnee 5	0.8658	-1.1091	0.8452	-1.1692
24	Mathematics will not be important to me in future career	susefulness 6	1.047	0.391	1.1056	0.7511
25	I see mathematics as a subject I rarely use in my future	susefulness 7	1.0594	0.5511	1.0564	0.4911
26	Mathematics is of no relevance to my life	susefulness 8	0.8939	-0.7691	0.843	-1.0692
27	Taking mathematics is a waste of time	susefulness 9	1.4127	2.0114	1.1174	0.6511
28	I expect to have little use for mathematics when I get out of school	susefulness 10	1.1388	1.2111	1.1358	1.1111
29	Mathematics doesn't scare me at all	sanxiety 1	1.1319	1.1811	1.0857	0.7411
30	I never get nervous during a maths test	sanxiety 2	1.0484	0.471	1.0931	0.8211
31	I have been at ease in maths classes	sanxiety 3	0.7596	-2.2692	0.7453	-2.2393
32	I have been at ease during maths tests	sanxiety 4	0.7017	-2.9893	0.6906	-2.9293
33	Mathematics usually makes me feel uncomfortable and nervous	sanxiety 6	0.831	-1.4592	0.8004	-1.5992
34	I usually get a sinking feeling when I try to do maths	sanxiety 7	0.9432	-0.4491	0.9879	-0.049
35	My mind goes blank and I am unable to think clearly while doing a maths test	sanxiety 8	1.0521	0.4711	1.03	0.271
36	I worry about my ability to solve maths problems	sanxiety 9	0.7548	-2.3592	0.8195	-1.5992
37	Mathematics makes me feel confused	sanxiety 10	0.7451	-2.4993	0.7334	-2.4793
38	My parents think that mathematics is one of the most important subjects to study	sparentattitude 1	1.0608	0.3811	1.2854	1.4313
39	My parents think I'll need mathematics for what I want to do after I finish secondary schooling	sparentattitude 2	1.0491	0.421	1.0242	0.221
40	My parents think I have to do well in mathematics to do advanced courses in university	sparentattitude 3	1.0949	0.7311	1.078	0.5611
41	My parents think I am the kind of person who could do well in mathematics	sparentattitude 4	0.8896	-0.9291	0.8682	-1.0391
42	My parents has always been interested in my progress in mathematics	sparentattitude 5	0.926	-0.4091	0.8714	-0.7091
43	My parents think I need to know only a minimum of mathematics for the future	sparentattitude 6	1.549	2.7715	1.5716	2.7316
44	My parents think advanced maths is a waste of time for me	sparentattitude 7	1.2311	1.3812	1.2067	1.1712
45	As long as I have passed, my parents doesn't care about my progress in mathematics	sparentattitude 8	1.1287	0.7911	1.0922	0.5611
46	My parents hate doing maths	sparentattitude 9	1.6319	2.7016	1.4024	1.8214
47	My parents have neve shown any interest in whether I take more maths courses or not	sparentattitude 10	1.1944	1.4312	1.2578	1.6913
48	I like maths puzzles	smotivation 1	0.8863	-0.8191	1.0111	0.121
49	Mathematics is interesting and enjoyable to me	smotivation 2	0.8285	-1.3992	0.7595	-1.8492
50	When I get a maths problem which I can't solve immediately, I will stick with it until I have the solution	smotivation 3	1.2245	1.8912	1.2577	1.9913
51	When a question is left unanswered in maths class, I continue to think about it afterwards	smotivation 4	0.9239	-0.5991	0.9228	-0.5491
52	Once I start trying to work on a maths puzzle I find it hard to stop	smotivation 5	1.0972	0.8611	1.0768	0.6511
53	The challenge of mathematics problems does not appeal to me	smotivation 6	0.8484	-1.4092	0.8845	-0.9891
54	I don't understand how some people can spend so much time on maths and seem to enjoy it	smotivation 7	0.9782	-0.159	1.0115	0.141
55	Figuring out mathematics problems does not appeal to me	smotivation 8	0.8352	-1.4492	0.958	-0.289
56	I do as little work in mathematics as possible	smotivation 9	0.9831	-0.099	1.0418	0.361
57	I would rather have some one give me the solution to a difficult maths problem than have to work it out for myself	smotivation 10	0.9263	-0.6391	0.9488	-0.3991
58	My parents encourage me to score well in mathematics	sparentbeh 1	0.7405	-1.3093	0.8877	-0.4891
59	My parents check my maths homework regularly	sparentbeh 2	1.3011	2.3213	1.2653	1.9213
60	My parents help me with difficult problems in maths	sparentbeh 3	1.376	2.9814	1.4366	3.1614
61	My parents asks me about my assessment result in maths	sparentbeh 4	1.0795	0.4811	1.1699	0.9112
62	My parents try to provide a good learning environment at home to study mathematics	sparentbeh 5	0.9395	-0.2991	0.8389	-0.8892
63	My parents encourage me to work hard on maths problems even though the problems are difficult	sparentbeh 6	1.356	2.1014	1.2515	1.4413
64	My parents frequently monitor the time I spend on mathematics at home	sparentbeh 7	1.4026	3.1814	1.5133	3.6915
65	My parents monitor the time I spend on watching TV	sparentbeh 8	1.3781	2.8014	1.4167	2.8014
66	My parents expects me to study advanced maths courses in university	sparentbeh 9	0.7988	-1.8892	0.797	-1.7892
67	My parents contact my teachers regularly to discuss about my performance in maths	sparentbeh 10	1.348	2.8813	1.4709	3.6015

Appendix M: Overall Item Fit Statistics- Parents

Entry	Name	Short name used	IN.MSQ	IN.ZSTD	OUT.MSQ	OUT.ZSTD
1	I think that mathematics is one of the most important subjects to study	pattitude 1	0.9476	-0.2391	0.9306	-0.3691
2	I think that my child will need good understanding in mathematics for what he/ she wants to do after finishing secondary schooling	pattitude 2	1.4119	2.3014	1.4218	2.2714
3	I think that my child has to do well in mathematics to do advanced courses in university	pattitude 3	0.8081	-1.2692	0.883	-0.6891
4	I think that my child is the kind of person who could do well in mathematics	pattitude 4	0.7786	-1.5092	0.7979	-1.2792
5	I think that my child needs to know only a minimum of maths for the future	pattitude 5	1.5008	2.6915	1.9683	4.542
6	I think that advanced maths is a waste of time for my child	pattitude 6	0.9688	-0.119	0.9453	-0.2591
7	I think that my child needs only a pass in maths	pattitude 7	1.4409	2.1514	1.543	2.7415
8	I am not concerned whether my child takes more maths courses in future	pattitude 8	1.0552	0.5111	1.1122	0.8811
9	I hate to do mathematics	pattitude 9	0.7469	-1.4493	0.6643	-2.1093
10	I am not concerned with the progress of my child in mathematics	pattitude 10	1.1663	0.9212	1.1912	1.0912
11	I encourage my child to achieve high marks in mathematics	pparentbeh 1	1.0779	0.4811	0.9719	-0.109
12	I regularly check my child's maths homework	pparentbeh 2	1.1315	1.1411	1.2893	2.0913
13	I help my child with difficult problems in mathematics	pparentbeh 3	0.826	-1.5892	0.8077	-1.5792
14	I regularly checks my child's assessment results in mathematics	pparentbeh 4	1.1006	0.7611	1.2118	1.3812
15	I try to provide my child with a good learning environment at home to study mathematics	pparentbeh 5	0.7406	-1.5293	0.7008	-1.8493
16	I encourage my child to work hard on maths problems even when the problems are difficult	pparentbeh 6	0.8549	-0.7791	0.7995	-1.1692
17	I frequently monitor the time my child spends on mathematics at home	pparentbeh 7	0.9355	-0.5191	1.0672	0.5511
18	I try to monitor the time my child spends on watching TV	pparentbeh 8	1.3164	2.0213	1.4623	2.6415
19	I try to contact my child's teachers regularly to discuss about his/her performance in mathematics	pparentbeh 9	1.1199	1.0711	1.3423	2.5113
20	I try to encourage my child to study well at school	pparentbeh 10	1.2516	1.3813	1.1907	1.1312
21	Mathematics doesn't scare me at all	panxiety 1	1.0893	0.8111	1.0847	0.6911
22	As a student, I was never nervous during a maths test	panxiety 2	1.289	2.3913	1.2317	1.7612
23	As a student, I usually have been at ease in maths classes	panxiety 3	0.873	-1.1091	0.957	-0.299
24	As a student, I usually have been at ease during maths test	panxiety 4	0.8272	-1.6092	0.8196	-1.4892
25	Mathematics usually makes me feel uncomfortable and nervous	panxiety 5	0.9427	-0.4191	0.9385	-0.3991
26	I usually get a sinking feeling when I try to do maths	panxiety 6	1.0721	0.6111	1.0914	0.6911
27	Mathematics makes me feel confused	panxiety 7	0.7591	-2.0692	0.7459	-1.9693
28	As a student my mind went blank and I was unable to think clearly while taking a maths test	panxiety 8	0.9455	-0.3691	1.1053	0.7411
29	I worry about my ability to solve maths problems	panxiety 9	0.9205	-0.6891	0.9435	-0.4191
30	I expect my child to work hard and do well at school	pexpectation 1	1.1702	0.9312	1.091	0.5611
31	I think that my child will study advanced maths courses in university	pexpectation 2	0.8601	-1.2191	1.1041	0.8211
32	I expect my child to get good grades in mathematics at school	pexpectation 3	0.9033	-0.4791	0.8698	-0.7291
33	I expect my child to go for university studies after finishing school	pexpectation 4	1.059	0.4011	1.1627	0.9612